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STATE OF NEVADA

SIXTH BIENNIAL REPORT

OF THE

DEPARTMENT OF HIGHWAYS

1927=1928

CARSON CITY, NEVADA
STATE PRINTING OFFICE—JOE FARNSWORTH, SUPERINTENDENT
1929

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TYPOGRAPHICAL
UNION
LABEL
WASHOE

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LETTER OF TRANSMITTAL

STATE OF NEVADA
DEPARTMENT OF HIGHWAYS

CARSON CITY, January 1, 1929.

HONORABLE F. B. BALZAR, *Governor of the State of Nevada.*

DEAR SIR: In accordance with a statute requirement, we take pleasure in presenting the sixth biennial report of the Department of Highways, covering the fiscal years 1927 and 1928, beginning December 1, 1926, and ending November 30, 1928.

In this report we have briefly outlined the accomplishments of the Department during the last biennial period, together with an outline of the proposed program for the forthcoming two years. As an introduction, we have reviewed the magnitude of the various programs completed since "The State Highway Law" was enacted.

Through this report we desire to express our appreciation to the United States Bureau of Public Roads and Federal Forest Service officials for their valued assistance; to the county officials for their splendid cooperation; to the employees of the Department for their loyalty and service to the interests of the State; and to yourself and all members of your administration for the helpful cooperation which has been given in conducting the business of this Department.

Respectfully,
BOARD OF HIGHWAY DIRECTORS,
By S. C. DURKEE, *State Highway Engineer.*

PERSONNEL OF THE DEPARTMENT OF HIGHWAYS

Administration

F. B. Balzar ..... Chairman Board of Directors
E. C. Peterson ..... Director
M. A. Diskin ..... Director
S. C. Durkee ..... State Highway Engineer
W. A. Young ..... Assistant State Highway Engineer
H. D. Mills ..... Office Engineer and Secretary to Board of Directors
E. C. Pohl ..... Chief Accountant

Departments

W. T. Holcomb ..... Chief Draftsman
Frank Morrison ..... Testing Engineer
J. P. Rawson ..... Equipment Superintendent
Dale Pruett ..... Right of Way Engineer
D. B. Renear ..... Inspector, Nevada State Police

Divisions

C. C. Boyer ..... Division Engineer, Division No. 1
Art Loforth ..... Division Engineer, Division No. 2
Waite Bruce ..... Division Engineer, Division No. 3
Frank H. Depp ..... Division Engineer, Division No. 4

A picturesque scene on the Clear Creek Highway to Lake Tahoe.

REPORT OF DEPARTMENT OF HIGHWAYS

INTRODUCTION

The year 1928 completes a twelve-year period since the Nevada State Legislature enacted what is commonly known as "The State Highway Law," which was approved March 23, 1917.

This Act, which is a general highway law for the State of Nevada, accepted the provisions of the Federal Aid Road Act, designated a System of State Highways, provided for a Department of Highways, and made provision for financing highway improvements—all of which was necessary to secure Federal aid and to inaugurate a highway improvement program consistent with the financial resources of the State.

In less than a month after the State highway law was signed, a Board of Highway Directors was appointed, and this newly created Board of Directors immediately appointed a State Highway Engineer and organized an engineering department, which made a detailed and extensive study of the rules and regulations as set forth by the Secretary of Agriculture for carrying on a program of highway improvements in accordance with the Federal Aid Road Act. After due consideration had been given to the preliminary investigations and their relation to constructing an economical system of roads, the necessary negotiations were entered into with the Federal Government, and a plan of improvements was arranged to absorb the money allocated to Nevada under the authority of the Federal Aid Road Act.

This Act was approved July 11, 1916, and is entitled "An Act to provide that the United States shall aid the States in the construction of rural post roads, and for other purposes." Under the provisions of this Act there was a certain amount of money allotted to Nevada for the period ending June 30, 1921. A large percentage of this money was to be expended upon "roads over which the United States mails were being or were to be transported," and the balance was to be expended upon "roads which were wholly or partly within the national forests."

Handicapped by the post road feature of this Act and by numerous other obstacles, the Department commenced a program to use the Federal aid allotted. Early in the spring of 1918 the Department was ready to begin its first construction program by letting several contracts covering a large amount of road improvements, but unfortunately war conditions prevented the fulfillment of actual construction.

Despite the fact that the first biennial period, 1917–1918, covered war years and no actual construction was accomplished, the results achieved, when a fair comparison is made, were of vast importance to the pioneer development and to the satisfactory solution of the many problems which arose in accomplishing the construction work of the following biennial periods.

After the termination of the war the Department looked forward to the years 1919–1920 as years of normal conditions, during which a large amount of construction work could be accomplished without being hampered by the multiplicity of obstacles and engineering difficulties which had previously existed.

Instead of war prices and conditions returning to normal, as had been anticipated, prices governing labor, materials, and equipment did not recede, in fact, the demand for most classes of labor exceeded the supply to such an extent as to cause prices to advance. The lack of labor was so acute in some localities as to force the Department to delay the construction program until a more opportune time.

Where the need for improvement was absolutely justified the Department proceeded with construction, and at the end of the year 1920 had completed 144.08 miles of road and six bridges, and had eight projects under contract, involving the additional improvement of 39.55 miles of road and two bridges.

A great amount of preparatory work, which facilitated the more rapid prosecution of the future construction and maintenance programs, was accomplished during the second biennial period, such as establishing an equipment organization and securing suitable equipment for carrying on the work.

The third biennium, 1921–1922, was one of great progress. During this period thirty-one contracts were awarded and three projects for construction by day-labor forces were authorized, which provided for the construction of 263.03 miles of road and 434 lineal feet of bridges.

It was during this biennium that an Act of Congress was passed which authorized the application of Federal aid on the equitable ratio of the area of unappropriated Government land within the State to the total area; provided for a seven per cent Federal Aid Highway System upon which Federal aid apportionments could be expended; and stipulated that no State could neglect the proper maintenance of the highways which had been constructed by Federal aid.

Soon after the passage of this Act the Department selected the seven per cent system in Nevada. For the purpose of making this selection a careful survey of the roads in each county was made, and from this survey the total road mileage of the State was estimated to be approximately 22,000 miles; and from this total mileage 1,540 miles were designated as Nevada's Seven Per Cent Federal Aid Highway System, subject to the approval of the Secretary of Agriculture.

Under the impulse given by the new provisions of the Federal Aid Road Act, highway construction reached its peak during the years 1923–1924. During this time highway construction was so increased in Nevada that the completed mileage was nearly doubled. At the end of 1922 there were completed, or under contract, 432.61 miles of State highways, 23 miles of Forest roads, and 2,031 lineal feet of bridges; by the end of 1924 there were completed, or under contract, 915.11 miles of highways, 3,436 lineal feet of bridges, and seven railroad grade separation structures.

During the years 1925 and 1926 highway construction was carried on under favorable conditions, but on a smaller scale than during the previous biennium; however, the mileage of improved highways was

increased from 915.11 miles of various types, completed and under construction, to 1,297.11 miles completed or under construction, 1,239.99 miles of which were completed State highway at the end of this period.

Table No. 1 shows the mileage completed, under construction and unimproved at the beginning of the sixth biennial period, December 1, 1926.

Table No. 2 shows the mileage completed, under construction and unimproved at the end of the sixth biennial period, November 30, 1928.

During the sixth biennium the mileage of the State Highway System was increased 556.33 miles by certain Acts passed during the regular session of the Legislature of 1927 and the special session of 1928, whereby Routes 17, 18, 19, 20, 21, 22, 23, and 24 were designated and incorporated as part of the State Highway System.

TABLE No. 1

Showing Mileage Completed, Under Construction, and Unimproved on the Federal Aid Highway System, State Highways Not on Federal Aid Highway System, and Entire State Highway System, December 1, 1926

Counties	Federal Aid System			State Highways Not on Federal Aid System			Entire State Highway System		
	Completed and under construction	Unimproved	Totals	Completed and under construction	Unimproved	Totals	Completed and under construction	Unimproved	Totals
Churchill	87.36	42.76	130.12		63.00	63.00	87.36	105.76	193.12
Clark	111.80	17.41	129.21	49.90	154.50	204.40	161.70	171.91	333.61
Douglas	28.32	26.42	54.74				28.32	26.42	54.74
Elko	140.31		140.31		229.00	229.00	140.31	229.00	369.31
Esmeralda	25.46	99.23	124.69		29.05	29.05	25.46	128.28	153.74
Eureka	72.70		72.70				72.70		72.70
Humboldt	84.69		84.69		134.00	134.00	84.69	134.00	218.69
Lander	106.83		106.83	13.60	98.40	112.00	120.43	98.40	218.83
Lincoln	38.62	15.74	54.36		102.39	102.39	38.62	118.13	156.75
Lyon	64.72	36.17	100.89		46.00	46.00	64.72	82.17	146.89
Mineral	*35.56	63.94	99.50	6.00	39.32	45.32	41.56	103.26	144.82
Nye	1.55	1.33	2.88	142.71	228.57	371.28	144.26	229.90	374.16
Ormsby	4.51	15.84	20.35				4.51	15.84	20.35
Pershing	58.17	18.20	76.37				58.17	18.20	76.37
Storey	5.40		5.40		3.88	3.88	5.40	3.88	9.28
Washoe	90.14	7.23	97.37		35.00	35.00	90.14	42.23	132.37
White Pine	116.53	103.64	220.17	12.23	89.03	101.26	128.76	192.67	321.43
Totals	1,072.67	447.91	1,520.58	224.44	1,252.14	1,476.58	1,297.11	1,700.00	2,997.16

*24.50 miles between Schurz and Hawthorne constructed by State and county cooperation without Federal aid, and must be improved to a higher standard to meet Federal aid requirements.

TABLE No. 2

Showing Mileage Completed, Under Construction, and Unimproved on the Federal Aid Highway System, State Highways Not on Federal Aid Highway System, and Entire State Highway System, December 1, 1928

Counties	Federal Aid System			State Highways Not on Federal Aid System			Entire State Highway System		
	Completed and under construction	Unimproved	Totals	Completed and under construction	Unimproved	Totals	Completed and under construction	Unimproved	Totals
Churchill	114.74		114.74		97.69	97.69	114.74	97.69	212.43
Clark	109.89	19.41	129.30	49.90	153.25	203.15	159.79	172.66	332.45
Douglas	46.01	10.31	56.32		18.00	18.00	46.01	28.31	74.32
Elko	140.31	125.09	265.40		240.00	240.00	140.31	365.09	505.40
Esmeralda	77.91	42.00	119.91		29.06	29.06	77.91	71.06	148.97
Eureka	72.70		72.70		125.00	125.00	72.70	125.00	197.70
Humboldt	84.69		84.69		171.73	171.73	84.69	171.73	256.42
Lander	109.90		109.90	13.60	192.50	206.10	123.50	192.50	316.00
Lincoln	54.36		54.36	[d]25.31	77.82	103.13	79.67	77.82	157.49
Lyon	68.52		68.52		88.86	88.86	68.52	88.86	157.38
Mineral	[a]82.89	12.80	95.69	6.00	80.20	86.20	88.89	93.00	181.89
Nye	[b]1.55	1.33	2.88	146.44	285.84	432.28	147.99	287.17	435.16
Ormsby	15.01	6.00	21.01				15.01	6.00	21.01
Pershing	74.90	1.22	76.12				74.90	1.22	76.12
Storey	5.40		5.40	1.14	2.74	3.88	6.54	2.74	9.28
Washoe	90.79	6.60	97.39		35.00	35.00	90.79	41.60	132.39
White Pine	[c]159.16	30.66	189.82	10.58	138.68	149.26	169.74	169.34	339.08
Totals	1,308.73	255.42	1,564.15	252.97	1,736.37	1,989.34	1,561.70	1,991.79	3,553.49

[a]24.50 miles between Schurz and Hawthorne constructed by State and Mineral County without Federal aid.
[b]1.55 miles through the Tonopah townsite constructed by Nye County and city of Tonopah without Federal aid.
[c]7.01 miles McGill north constructed by State and White Pine County without Federal aid.
[d]25.31 miles between Caliente and Pioche, Lincoln County, not on Federal Aid Highway System, but was constructed with Federal aid funds made available prior to Federal Aid Highway Act of 1921.
The mileage constructed by State and county without Federal participation must be improved to higher standard to meet Federal aid requirements.

TABLE No. 3
Miles Completed and Under Contract

Type of construction	Miles completed 1917–1926	Miles completed 1927–1928	Miles completed to date	Miles under construction	Total miles
Grading only	235.34	27.42	240.18		240.18
Grading and crushed rock or crushed gravel	929.52	226.44	1,063.12	63.23	1,126.35
Grading and asphalt macadam surface	20.56		20.56		20.56
Grading and asphalt concrete surface	1.96		1.96		1.96
Grading and cement concrete surface	47.07		50.99		50.99
Gravel surface, projects previously graded		*18.00			
Cement concrete surface, projects previously graded		*3.92			
Reconstruction, widening existing roadway and surface		†104.91		25.93	
Bituminous treated surface (mixed method)	10.16	111.50	121.66		121.66
Totals	1,244.61	492.19	1,498.47	89.16	1,561.70

*Under column headed "Miles Completed to Date," these miles are included in "Grading and Crushed Rock or Crushed Gravel" and "Grading and Cement Concrete Surface," respectively. The miles of "Grading Only" are reduced to correspond.

†This mileage does not change miles of "Grading and Crushed Gravel" under column "Miles Completed to Date."

Miles of "Bituminous Treated Surface" (mixed method) reduces the mileage of "Grading Only" and "Grading and Crushed Rock or Crushed Gravel" to a corresponding amount.

SUMMARY
Construction Completed 1927-1928

	Grading only	Grading and gravel	Gravel only	Cement concrete only	Reconstruction	Oiling
Contract work	25.33	221.02	18.00	3.92	68.76	
Forest highways	2.09	4.06				
Day labor		1.36			36.15	111.50
Totals	27.42	226.44	18.00	3.92	104.91	111.50

In the table showing "Miles Completed 1917–1926" the miles of "Grading Only" have been increased 2.11, and miles of "Grading and Crushed Rock or Crushed Gravel," 1.51, as this mileage was completed prior to this biennium, but omitted from the Fifth Biennial Report.

The mileage of "Grading and Asphalt Macadam Surface" has been reduced 3.45 and mileage of "Grading and Crushed Rock or Crushed Gravel" increased to a corresponding amount. This mileage was shown incorrectly in the Fifth Biennial Report.

BIENNIAL REPORT

During this biennial period many changes of major and minor importance have been made. One of the most important was the amending of the State highway law, thereby making the Governor, the Attorney-General and the State Controller of the State of Nevada the Board of Directors of the Highway Department. This new board took over the duties of office on April 1, 1927; and at a special meeting held on May 31, 1927, appointed Mr. S. C. Durkee State Highway Engineer.

In accordance with this important change in the personnel of the Board of Directors the Department was reorganized and new policies formulated, which, for the main part, have been consistent with meeting the ever increasing demands for both new construction and reconstruction. These changes redistributed the engineering responsibilities, reduced the supervising engineering forces, and have been directly responsible for a large saving in the overhead expense of maintaining the various subdivisions of the Department. Under these new arrangements the maintenance engineer and one or more assistant engineering

positions have been abolished by placing the maintenance of each division in direct charge of the division engineer, who also has been given direct supervision over all new construction, reconstruction and betterment work within his division.

Early in the summer of 1927 the United States Bureau of Public Roads notified the Department that they were in favor of reconditioning and resurfacing approximately 111 miles of the Victory Highway, U. S. Route 40, between Lovelock and the Nevada-Utah state line. The various sections indicated in their report were the ones that had been constructed prior to 1924 and on account of disintegration were rapidly becoming a serious and expensive maintenance problem. The Bureau of Public Roads also requested the reconstruction of the section between Salt Wells and Sand Springs on the Lincoln Highway, U. S. Route 50. The original construction of this section which crosses the four and eight mile flats in Churchill County was one of the Department's most difficult road building problems on account of the character of the only available soil for building the embankments. The soil used was of a light spongy nature and, after being incorporated into the road embankment, did not consolidate sufficiently, even with a crushed rock surface, to support the traffic load. The road was never entirely satisfactory and, therefore, expensive to maintain under ordinary traffic.

Notwithstanding all this, besides the program which had been outlined and approved for the year, which did not include any reconstruction or betterment work, different communities insistently demanded the construction of new roads without first taking into consideration the restricted income to the Department for maintenance purposes.

The maintenance of the Federal Aid Highway System is a State obligation which was assumed when the State accepted the provisions and benefits of the Federal Aid Road Act. With the rapid growth of the highway system the obligation has grown accordingly, and is now of primary importance and must be considered in the present and future expansion of the State Highway System. The original Federal Aid Road Act of 1916 contained a provision regarding the maintenance on roads constructed by Federal aid funds. Prior to 1920 several States neglected to make the proper provision for maintenance. This caused the next Congress to include in the amended Federal Highway Act of 1921 a very definite and drastic clause with reference to maintenance requirements on all roads constructed under the Federal Aid Act. This clause compels every State to make proper provisions for maintenance of roads built in cooperation with the Federal Government.

The maintenance clause of the Federal Act has been published in a previous biennial report but under the present ambitious road building program it is worthy of an additional publication in order that proper legislation may be enacted. The maintenance clause of the Federal Act is contained in section 14 and is as follows:

> SEC. 14. That should any State fail to maintain any highway within its boundaries after construction or reconstruction under the provisions of this Act, the Secretary of Agriculture shall then serve notice upon the State Highway Department of that fact, and if within ninety days after

receipt of such notice said highway has not been placed in proper condition of maintenance, the Secretary of Agriculture shall proceed immediately to have such highway placed in a proper condition of maintenance, and charge the cost therefor against the Federal funds allotted to such State, and shall refuse to approve any other project in such State except as hereinafter provided.

Upon reimbursement by the State of the amount expended by the Federal Government for such maintenance, said amount shall be paid into the Federal Highway Fund for reapportionment among all the States for the construction of roads under this Act, and the Secretary of Agriculture shall then approve further projects submitted by the State as in this Act provided.

It has been, and still is, the policy of this Department to conform to all the requirements of the Federal Act, and in programming the work

Natural desert road prior to improvement.

of the Department under the budget system, adequate provision is made for maintenance. With the increase of approximately 150 miles of new road each year, the cost of maintenance has increased to a point where it has become necessary to first consider future maintenance costs before considering construction costs. Our highway problem of today is not one of mileage of additional improved highways, but one of regulating the construction of new improvements in proportion to the income for maintenance.

After the Department was reorganized, the numerous problems and their relation to one another were carefully considered, and a plan was arranged for a balanced program to include the new construction, which had been outlined and approved by the former Board of Directors; a certain amount of reconstruction as suggested by the Bureau of Public Roads, and the preparatory work to the building of an experimental section of a bituminous treated crushed gravel surfaced road.

In formulating the program a large amount of study was given to the various phases of the work and their ultimate effect on the ever increasing costs of maintenance. In planning the reconstruction and oil treating portion of the program, the rapidly increasing traffic load was taken into consideration as well as the condition of the road. With the cooperation of the Bureau of Public Roads and by the adoption of the method of bituminous treating gravel surfaced roads, as had proved successful in application by the California Highway Commission, a feasible and economical plan for reconstructing and oil treating the worn out sections of the State Highway System was developed, which has been justified during the last half of the biennium by the results obtained in constructing 111.50 miles of this type of improvement.

At the end of the first six months of 1927, maintenance expenditures had exceeded the income. Drastic policies were adopted to meet the deficit. Several counties were billed for a portion of the maintenance expenditures in their respective boundaries, and the maintenance force

Desert road in course of construction.

was decreased to the minimum. During the last half of the year no equipment of any kind was purchased excepting a few light cars for supervising engineering purposes, which were absolutely necessary for carrying on the construction program.

It is a pleasure to state that instead of starting the program covering the work for 1928 with a deficit, the Department's books showed an appreciable balance.

Under the program as approved for 1927, many important projects were completed. Perhaps the one most worthy of mention was the completion of the 58-mile section between Fernley and Lovelock, on the Victory Highway, U. S. Route 40, which gave Nevada an improved transcontinental highway from the Nevada-California state line, via Reno, Sparks, Wadsworth, Fernley, Lovelock, Winnemucca, Battle Mountain, Carlin, Elko and Wells to the Nevada-Utah state line.

Upon the completion of this section it was in excellent shape and was considered one of the longest good sections of gravel surfaced roads in the United States. Unfortunately a large portion of the early roadway surfacing was underdesigned for the volume of traffic it had to sustain, and went to pieces rapidly under the increased traffic load of the past two summers. When the sections were built, during the early years of Nevada's road building program, it was impossible to foresee the present-day traffic load, or the rapid deterioration of the surfacing material caused by the combination of traffic and peculiar climatic conditions.

The annual loss of material from the gravel surfaced roads in Nevada amounts to about three-eights of an inch of compacted gravel, which is equal to 120 cubic yards, loose measurement, to the mile on a gravel surfaced width of 18 feet. It costs on an average of $1.25 a cubic yard for the replacement of the lost surfacing material. A further analysis

Typical gravel surfaced highway.

of the loss of the binder and gravel shows that there is an annual loss of about $160 a mile during the first two or three years after the surfacing has been placed, and from then on the loss gradually decreases as the surface becomes more consolidated, until finally no further loss is noticeable.

On account of the arid climatic condition of Nevada there is not enough moisture to properly keep the gravel surfacing sufficiently compacted to withstand the traffic load, consequently, when the gravel becomes loosened it is thrown off the roadway section, and the binding material is blown away. Both materials are unrecoverable and have to be replaced by additional materials in order to keep the consolidated mass built up to the required thickness which is necessary to offset the surface from breaking up and potholing.

Corrugation presents the most aggravating condition with which the Department has to contend in its effort to keep the gravel surfaced roads fairly smooth and serviceable. A great deal of study has been

given to this condition and innumerable theories have been advanced relative to the cause; but with all the thought that has been expended we still have sections of gravel surfaced roads subject to corrugation in its worst form, which for some unknown reason maintenance methods have not overcome.

It is noticeable that corrugations are worse on some sections and under certain conditions than on other sections under the same conditions. The Department is satisfied that the variation mentioned is due not only to the type of crushed gravel or rock, but to the character of the binding material as well. For instance, a surfacing material that is bound together with a sandy binder corrugates more freely than one bound together by sand and clay, clay, river silt, or mineral binder. Accordingly, the Department has made a comprehensive survey and analysis on all gravel and binder deposits that have been used in connection with the construction of gravel surfaced roads during the past

Gravel windrowed in center of road as first operation to widening gravel surface.

two years. It is important to realize that in some localities it is economically impossible to supply a suitable binder on account of the character of the local materials. In such cases the best local material is chosen, which does not always come up to the requirements of a good binder.

Gravel surfaced roads are in no way permanent in character, and even with the use of ideal materials for surfacing, they deteriorate rapidly and become a heavy burden to maintain in passable condition; therefore this type of construction can only be classed as a permanent foundation for future improvement by other stages of construction.

Realizing the many conditions adverse to keeping the highway system serviceable, and appreciating the benefits derived by the communities and by the State in keeping the State Highway System in the best condition possible, a plan was outlined for the year 1928 consistent with the immediate need of reconstructing the worn-out sections and the general betterment of the entire system. In addition there was

included in the 1928 program the construction of several sections of the North and South Highway, Route 3, between Tonopah and Hawthorne, and two sections of the Lincoln Highway between McGill and Wendover. For years there has been a determined effort made for both the improvement of the eastern connection of the Lincoln Highway and for the completion of the North and South Highway. The delay in making these improvements was in no way premeditated, but was due to certain financial conditions and route designations.

The North and South Highway could not be financed from county funds and, therefore, the financing was necessary through legislative action, which was given by the session of 1927 when a certain Act was amended, thereby authorizing the State Highway Department to issue an additional $300,000 in State Highway bonds to meet the State's and counties' share of the costs of improving the North and South Highway, and for the cost of constructing a portion of the State road between Beatty and Goldfield. It was generally understood that the

Showing trenching subgrade as second operation.

money was to be divided, $200,000 for the North and South Highway and $100,000 to be applied where necessary.

In order to clear up any misunderstanding relative to the improvements between Tonopah and Hawthorne, the following must be given due consideration:

According to the State highway law, the State Highway Engineer is required to have his proposed program in such shape as to be able to submit it to the various counties interested on January 10. The program must cover the improvements, by counties, for the ensuing year. Under the Federal Aid Road Act a certain amount of money is allocated to Nevada for each year. The Government's fiscal year begins July 1, and ends June 30, the Department's fiscal year begins December 1 and ends November 30—in other words the Department's fiscal year is seven months ahead of the Federal Government's.

During the early years of the highway program under the Federal

Act money was apportioned to Nevada, as well as to all other States, on a fifty-fifty basis; *i. e.*, the Federal Government paid half of the costs of actual construction. Later on the Federal Act was amended, making the application of Federal aid to Nevada on the equitable participating costs of 87.72 per cent to Nevada's 12.28 per cent. During 1928 the Government increased its share to 88.85 per cent. Since the Federal Act was amended there has been a gradual increase in the demand for new roads in all sections of the State. In an effort to meet the requirements of the people in general, the Department has used each year's apportionment of Federal aid funds. Federal aid becomes available at the beginning of the Federal Government's fiscal year, but after January 1, and before the funds become available, the money can be placed under agreement in proportion to the amount approved for each project listed in the State Highway Engineer's program; by

Completed reconstructed highway prior to bituminous treatment.

this arrangement a large percentage of the money allocated to Nevada is under agreement during the first seven months of the State's fiscal year. This procedure is necessary to enable the Department to take advantage of the spring and summer months which are the feasible seasons for construction activities.

It is easy to see, when one is conversant with the actual facts relative to placing Federal aid under agreement, that a legislative Act whereby money is legislated for improvements cannot be applied to meet Federal aid until the following year, unless the State Highway Engineer's program does not absorb the year's Federal appropriation. As it is not the policy of the Engineer to underestimate the program, it is very

seldom, if ever, that there is any Federal money not accounted for within the program. Under the policy of overestimating the costs of the proposed program there is usually a certain amount of Federal money to be placed under agreement toward the end of the construction season. The difference is due to the actual cost of construction, which is, as a rule, about 10 per cent less than the Engineer's estimate.

Referring again to legislating the money for the construction of the North and South Highway; when the amendment governing the increase in the State highway bond issue was enacted, the Engineer's program had already been placed before the Boards of County Commissioners, which constituted approval of the year's program; therefore, there were no Federal funds for the work until the Federal appropriation for 1929–1930 was available for placing under agreement. Just as soon as possible after the Federal money became available, over ninety miles between Tonopah and Hawthorne were included in the program, and to date over 60 miles have been completed, with the balance of the ninety miles under contract, leaving only a short section between Luning and Hawthorne for future improvement.

In connection with completing the North and South Highway as soon as possible 14.81 miles of improved highway were built during this biennium between Yerington and Schurz, besides the 7.19 mile section south of Gardnerville and the construction, reconstruction and oiling of the section between Carson City and Minden.

The designation of an eastern connection of the Lincoln Highway with Utah had been under advisement for several years without any tangible result, until, by the combined efforts of the State Highway Department, the Lincoln Highway Association, the Committee of Fifteen, and other interested parties, a tentative connection was designated from Wendover south to McGill. This was proposed only as a possible connection dependent, of course, upon the approval of the Bureau of Public Roads. The Wendover-McGill connection, however, was approved by the Secretary of Agriculture, and immediately thereafter the Department placed two survey parties on the location which had been outlined by a reconnaissance report that had been previously made to support the arguments used in making the final decision.

Immediately upon the completion of the location of the two sections of this route, the plans and specifications were made, and the projects were placed under agreement.

At the present time 34.74 miles of the road are under contract, while the balance has been incorporated into next year's program with the expectation of completing the total improvements some time early in the spring of 1930.

The program for 1929–1930 includes the completion of the Lincoln Highway; additional construction on the North and South Highway; the reconstruction of a large portion of the Victory Highway and Arrowhead Trail; reconstruction and betterment work on the Lincoln Highway; construction of two sections between Goldfield and Beatty; construction from Wells north toward Contact, on the Wells-Rogerson Highway; as much oil treating as is economically possible, besides the

general maintenance; and whatever additional work is planned by the 1929 Legislature.

In arranging the program for 1929, more consideration has been given to reconstruction than to construction in order to relieve the cost of maintenance on sections which are rapidly going to pieces and are in constant need of repair. On the Victory Highway it is planned to reconstruct and oil treat 142.99 miles of gravel surfaced roads.

The sections chosen are designated as follows:

16 miles northeast of Fernley to 7.48 miles east of Lovelock	50.22 miles
Humboldt House to Humboldt County line	27.19 miles
Winnemucca to 13.83 miles west	13.83 miles
6.57 miles west of Stone House to Battle Mountain	25.93 miles
West Elko County line to Elko	25.82 miles
Total	142.99 miles

In addition to reconstruction work on the Victory Highway the following reconstruction and oiling are included for 1929:

Leeteville to Hazen	8.29 miles
6 miles southwest of Apex to Crystal	22.51 miles
Gardnerville to 7.19 miles south	7.19 miles
Total	37.99 miles

Besides reconstructing and oil treating 180.98 miles of gravel surfaced roads, the program also includes constructing 54 miles from the Elko-White Pine County line to Wendover, which will give Nevada another improved transcontinental highway. The estimated cost for the total amount of work for the year, as proposed, amounts to $1,205,317.[redacted], of which the Federal Government's share will be $957,995, under the appropriation for the Federal Government's fiscal year 1930–1931.

STATUS OF STATE HIGHWAY CONSTRUCTION AND RECONSTRUCTION IN THE VARIOUS COUNTIES

Churchill County

During this biennium 34.3 miles of graded and gravel surfaced highway were constructed, and 19.27 miles of highway were reconstructed.

The newly constructed sections are located between Sand Springs and a point 1½ miles west of Frenchman's Station, on the Lincoln Highway, U. S. Route 50; and between the west Churchill County line and the Pershing County line, on the Victory Highway, U. S. Route 40.

The reconstructed sections lie between Salt Wells and Sand Springs, and between Leeteville and Fallon, on the Lincoln Highway.

A very decided improvement was made in reconstructing the Salt Wells-Sand Springs section. The old roadbed was widened from a 20 to 26-foot width. A selected material mat was placed over the top and a new crushed gravel surface constructed.

The construction of the section of the Victory Highway in Churchill County was a part of one of the most outstanding accomplishments of the biennium and was the final link in completing a transcontinental highway across the northern portion of the State.

A substantial donation of $25,000 from certain San Francisco bay cities was applied toward the cost of constructing the section on the Victory Highway between the west Churchill County line and the Pershing County line.

Clark County

Construction during the past two years in this county totaled 24.89 miles of graded and graveled highway; 31.75 miles of reconstruction; and 40.39 miles of bituminous treated surface (surface mixed method); also a concrete and steel grade separation structure over the Union Pacific Railway in the vicinity of Jean.

On account of the enormous increase in all classes of motor vehicle traffic, which amounted to over 100 per cent during the biennium, it was necessary to widen the section from Las Vegas to Jean, on the Arrowhead Trail, U. S. Route 91, to withstand the present and future traffic load.

With the completion of 24.89 miles of new highway on the Arrowhead Trail, another transcontinental highway was completed from the

Winter construction in the Sierra, Clear Creek Highway.

Nevada-Utah state line to Jean, with the exception of 6.33 miles in the vicinity of Apex, which is to be constructed during 1929; and 12.09 miles between Jean and the California state line, which will be constructed just as soon as possible after California designates a connection at the state line; and 1 mile at the Arizona state line is awaiting Arizona's designation for the proper connection. The section of bituminous treated surface lies between Jean and a point 6 miles southwest of Apex, through the city of Las Vegas.

The city of Las Vegas participated in the cost of treatment of the State highway through the city and paid the total cost of improving Fifth Street from the city limits to Fremont Street, and Main Street from the city limits to Fremont Street. This improvement consisted of widening from a roadway surface width of 18 feet to a street width of 50 feet.

Douglas County

The mileage completed during the past two years consisted of 5.07 miles of graded highway; 12.62 miles of graded and graveled highway; 2.37 miles of reconstruction; and 7.8 miles of bituminous treated surface.

One of the most important improvements was the building of a new highway between Gardnerville and a point 2 miles north of Carter's, located on a nearly straight line between Gardnerville and the foothills near the Ruhenstroth ranch. This improvement eliminated one of the poorest connecting links in the North and South Highway and shortened the distance approximately one-half mile.

Another accomplishment worthy of notice was the construction of the section between the west Ormsby County line and Spooner's Station as a part of the Clear Creek road to Lake Tahoe, constructed to eliminate the old Kings Canyon road.

The Bureau of Public Roads, using Forest Highway funds, con-

Heavy rock work on the Clear Creek Highway.

structed 2.09 miles of highway from Glenbrook to a point 1 mile west of Spooner's Station with the expectation of completing the highway in Douglas County between the Ormsby County line and Glenbrook during 1929.

The Forest Highway funds expended for the above mentioned work amounted to approximately $79,000.

Elko County

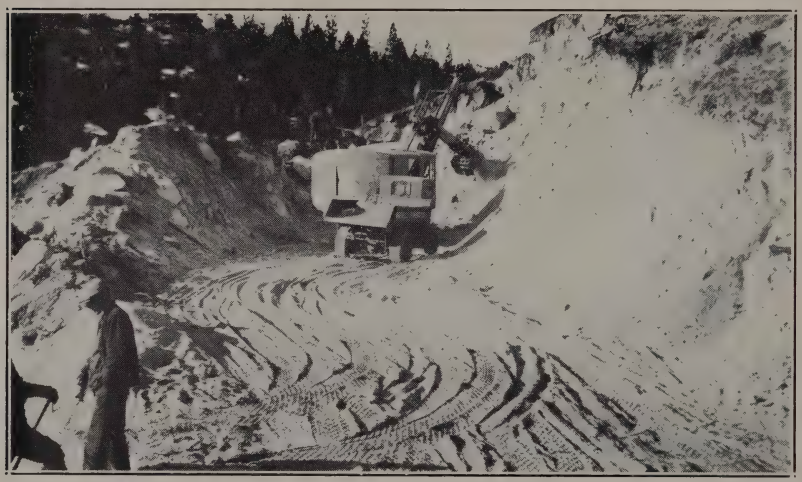
No highway construction was carried on in Elko County during this biennium as the originally designated Federal aid mileage had been completed during the previous years. However, during the special session of the State Legislature of 1928 a new highway route designated as No. 24 was created and incorporated as part of the State Highway System within Elko County. This forms a portion of the eastern connection of the Lincoln Highway between McGill and Wendover.

During the early part of 1928 the Highway Department requested the Secretary of Agriculture to place this route on the Federal Aid Highway System. Upon receiving approval, the Department immediately arranged to complete the final location of the proposed highway and, as the surveys were completed, began working on the plans and estimates for the construction in Elko County during 1929.

During the past year the Secretary of Agriculture was also requested to place 50 miles of the Wells-Rogerson Highway, Route 13, on the Federal Aid Highway System; also 21.69 miles of Route 13 between a junction with Route 24, 5 miles south of the White Pine-Elko County line to a point 5.24 miles north of Currie. These sections were approved for Federal participation in construction costs and are now a part of the Federal Aid Highway System.

Esmeralda County

During the past biennium 68.98 miles of graded and gravel surfaced



Gas shovel at work in heavy cut, Clear Creek Highway.

highway were placed under construction. Of this mileage all but 20 miles have been completed during 1928.

The work in this county was made possible by an Act of the 1927 Legislature authorizing the issuance of State Highway bonds in the sum of $300,000, with the understanding that at least $200,000 should be applied on the construction of the North and South Highway, Route 3 of the State Highway System.

The contract for the first 20-mile section between Tonopah and 8 miles west of Millers was awarded on January 25, 1928; and the progress made to date assures the Department that over 90 miles between Tonopah and Hawthorne will be completed by the early part of 1929.

Eureka County

No construction was carried on in this county on the Federal Aid Highway System during 1927–1928, as the total improvement was completed and there was no immediate need for reconstruction.

Humboldt County

The highway activities in this county were confined to reconstructing a section from a point 6½ miles west of Stonehouse to the east Humboldt County line, on the Victory Highway. This work is still in progress and will be completed about the first of April, 1929. This section was one of the worst pieces of highway in the State and had become a hazard to the traveling public. The reconstruction included

Channel change paralleling embankment location during construction of Clear Creek Highway.

widening both the roadway and surface. This section is included for bituminous treatment in the 1929 program.

Lander County

The work in this county consisted of reconstructing 8.52 miles of highway between the west Lander County line and Battle Mountain, on the Victory Highway, and a certain amount of betterment work on the Lincoln Highway near Austin.

Lincoln County

During 1927–1928, 15.74 miles of graded and graveled highway were completed, and 1.7 miles of previously graded highway were gravel surfaced.

The newly constructed section is between Stonehouse and Pony Springs on Route 7. The gravel surfacing was done between Pony Springs and a point 1.7 miles north.

Lyon County

During this biennium 19.48 miles of graded and graveled highway were constructed, 5.11 miles reconstructed, and 10.48 miles bituminous surface treated.

A concrete and steel overhead crossing of the Southern Pacific tracks just east of Fernley was also built during this period.

Of the graded and graveled highway constructed, 2.76 miles lie between Fernley and a point 2.76 miles east, on the Victory and Lincoln Highways; 13.17 miles between the junction of the Lincoln and Victory Highways and the north Lyon County line; and 3.55 miles east of Yerington on the North and South Highway.

The reconstruction and oiling were done between the west county line and 2.76 miles east of Fernley. The bituminous treated surface of 6.93 miles was extended from the junction of the Victory and Lincoln Highways to a point 6.93 miles north.

Mineral County

During 1927–1928, 11.25 miles of graded and gravel surfaced highway were constructed between the west county line and Schurz, on the North and South Highway. The balance of the new construction was between the east county line and a point 12.8 miles east of Hawthorne.

A total of 47.34 miles of graded and gravel surfaced highway was placed under construction and all but 8.48 miles have been completed to date.

This construction was made possible by the Act of the 1927 State Legislature authorizing the State Highway Department to issue bonds covering the State's share of the cost of the work.

Nye County

A short section of .64 of a mile of highway was constructed between the west Nye County line and Tonopah by the State and county, without Federal participation. The work consisted of grading and graveling.

Ormsby County

The following construction was completed in this county during the biennium: 3.13 miles of graded and graveled highway between Carson City and the south county line; and 7.54 miles of grading between the junction of the Carson-Minden road and the west Ormsby County line. The latter is a part of the Clear Creek Highway, a high gear road to Lake Tahoe.

In conjunction with the grading, 1.49 miles of the Clear Creek road were gravel surfaced, and 2.15 miles at the lower end were bituminous treated. The section from Carson City to the south county line was also bituminous treated.

The total work done was: 7.54 miles of grading only; 3.13 miles of grading and graveling; 1.49 miles of gravel surfacing on a previously graded road; and 5.28 miles of bituminous treatment.

Pershing County

Highway construction during the past two years was confined to the grading and graveling of a section of the Victory Highway, or U. S. Route 40, between the west Pershing County line and Lovelock, completing the construction of this route across the county, with the exception of approximately 1½ miles through the city of Lovelock. This section of highway, together with the section constructed in Churchill County, and the grade separation structure at Fernley, completed the last link of the Victory Highway across the State of Nevada.

Storey County

Through State and county cooperation, 3½ miles on Route 17, from

Bituminous treated crushed gravel surface, between Ely and East Ely, White Pine County.

the First Ward schoolhouse in Virginia City to a point below Gold Hill, were reconditioned by reshaping C Street to the Divide; improving the roadway and drainage from the Divide to a point in Gold Hill; and gravel surfacing and oil treating C Street from the First Ward school through Virginia City to the Divide, a distance of 1.23 miles. This accomplishment was due to the commendable assistance rendered the Department by the people of Virginia City and Gold Hill.

Washoe County

During this biennium 15.72 miles of graded and graveled highway were completed between Hafed and Derby; 3.92 miles of cement concrete surface were placed on a previously graded roadway between Verdi and the California state line; and 29.32 miles of the highway between Sparks and the east county line near Wadsworth were reconditioned, the reconditioning consisting of widening the roadway in

certain places, increasing the superelevation on practically all of the curves throughout the Truckee canyon, and placing additional crushed rock or crushed gravel on the existing surface in order to prepare the surface for the bituminous treatment which was applied shortly thereafter.

All the work in this county was done on the Victory Highway, U. S. Route 40.

White Pine County

During the biennium more work was performed in this county than in any other county within the State.

Much of the work was of a preparatory nature, such as completing the surveys and arranging for the plans and specifications on the section between McGill and the White Pine-Elko County line; and making the survey from a point near East Ely to Connor's Pass.

During 1928, 43.77 miles of highway were placed under construction for grading and graveling; but, due to severe winter weather, 34.75 miles of the above construction have been left for completion in the spring of 1929.

Between Keystone and McGill 16.98 miles were reconstructed and oil treated, making one of the finest sections on the State Highway System.

In conjunction with the State's program for Route 7, by Federal aid alone, 4.06 miles of forest highway were constructed through Connor's Pass, and 4.96 miles approaching the pass were constructed by State and Federal funds.

FOREST HIGHWAYS

The National Forest Highway System in Nevada comprises 460 miles of roads which are within the National Forest Reserves or are connections between reserves. These reserves are known as the Tahoe, Mono, Toiyabe, Nevada and Humboldt National Forests. Of the 460 miles, 296.0 are also a part of the State Highway System and 122.0 are on the Federal Aid System. The total forest highway mileage is divided into mileage actually within National Forest Reserves, which amounts to 160.6 miles, and mileage of connecting roads between reserves, amounting to 299.4 miles.

Since 1922 the Bureau of Public Roads, using Forest Highway funds, have constructed 120.15 miles, without State aid, at an approximate expenditure, including administrative and equipment costs, of $724,489. Of this mileage 98.85 miles are on the State Highway System and are included in Table No. 3, "Miles Complete and Under Contract."

Forest highway projects constructed during the past two years are: 4.06 miles of grading and surfacing with crushed rock or gravel on State Route No. 7, Connor's Pass section in White Pine County; 2.09 miles of grading only on State Route No. 3, between Glenbrook and 1 mile west of Spooner's Station, in Douglas County.

Both of these projects are important links in the State Highway System and the construction was extremely heavy, entailing the expenditure of the entire forest highway apportionment for the two years.

The Federal apportionment each year for forest highway projects within Nevada amounts to approximately $97,000, which is expended

in the construction of certain sections of the Forest Highway System. This construction must meet with the joint approval of the District Forester, the District Engineer of the Bureau of Public Roads and the Nevada State Highway Engineer.

It has been necessary for the State to construct certain sections of the forest highways lying within the State Highway System in order that gaps in the intrastate highways might be completed at an earlier date than would have been possible if the work had been delayed until forest highway funds were available. Federal aid has been used in carrying out the construction of these sections.

The total mileage constructed in this manner amounts to 24.48 miles located as follows: 18.02 miles on State Route No. 2 between Campbell Creek Ranch and Railroad Pass, 1.50 miles through the city of Austin, in Lander County, and 4.96 miles adjoining the forest project at Conner's Pass on State Route No. 7, in White Pine County.

NATIONAL HIGHWAY LEGISLATION

National highway legislation is a matter of deep interest to Nevada, due, of course, to the fact that Federal participation in actual construction is an important factor in Nevada's road program.

Federal aid is again assured for the years 1930 and 1931 because of the passage by the Seventieth Congress of the bill authorizing Federal aid appropriations of $75,000,000 for highway construction in each of these years.

In addition to the above appropriations for main highways, the bill, as signed by the President, carries $7,500,000 for each of the fiscal years 1930 and 1931 for building forest roads and trails.

These Federal appropriations for 1930 and 1931 continue the policy of the Government to make advance appropriations so that provision may be made for the continuity of work on the Federal Aid System and time may be given to the Federal and State departments to outline their construction program.

Two other measures in which Nevada is interested were introduced to this same Congress. (1) The Oddie-Colton bill, which amends the Federal Highway Act in several important particulars, making it more flexible and liberal, was passed. (2) The measure appropriating $3,500,000 a year for three years for the construction of isolated sections in the Federal Aid Highway System on Government Reservation lands passed the House and Senate, but was finally lost because of the President's veto.

HIGHWAY PLANS AND ESTIMATES

Many factors control the nature of highway plans and the manner in which the quantities of various items are estimated. Following the adoption of a highway route by the Legislature, inspection must be made in the nature of a reconnaissance to determine the approximate location of the route.

Reconnaissance is made by a skilled locating engineer in conjunction, usually, with a representative of the Bureau of Public Roads. The principle of this inspection is to determine the most feasible location for the particular section of roadway under consideration.

Locations of cities and towns or communities, cultivated lands, mountainous regions or swampy land, excess grades, sun exposure

when in snow country, soil conditions, necessary curvature, length of line between controlling points, amount of funds available and type of road desired, all tend to govern the preliminary location of a highway route. Control points, ordinarily, are two or more fairly large towns through which it is desired to have the highway constructed. The towns and cities in Nevada are so distantly spaced that an endeavor is always made to exclude as few from the located highways as is practicable.

Available funds and type of road desired perhaps have more real weight in determining the location than do all the other mentioned features. With the desire of accommodating as many of the people in the State as possible, together with the through tourists, and at the same time of making the small amount of available money extend over as great a mileage as can be done, a happy medium has been adopted whereby a fairly good type of road is being constructed which is semi-permanent in design, fairly easy to maintain, and at the same time does not have an excessive construction cost.

The engineer, in making a study for road development, therefore considers the type of roadway which is contemplated, and certain desirable features must necessarily be sacrificed for expense.

After the reconnaissance reports have been given due study, a selection is made of a location for a route and a survey party placed in the field to make the final survey for the roadway.

Should the original control points be so near together that very slight changes only would occur in location or should the route be so self-evident as to alignment that separate study is not required, the reconnaissance and survey may be, and at times are, made simultaneously.

This survey consists of staking the desired alignment in the field, running levels and cross-sections over the entire line in order that quantities of excavation may be computed, noting all topography which might be of interest or might in some way govern the construction, and tying the surveyed line to section corners to facilitate the purchase of rights of way.

Extensive notes are taken in the field by the survey party. These notes are turned in to the drafting room, where plans are prepared.

Immediately after the adoption of a surveyed line a study is made in the field for drainage structures. These structures, in innumerable cases, control the height at which the roadway must be held and the quantities involved.

In extreme cases where mountainous country is being traversed it may be found, after preliminary estimates have been prepared, that better construction could be secured by slight changes in the alignment. These changes are made in the office and, if the survey party is in position to make the revisions, they are cared for in the field also.

On the completion of the plans for any one section or project, they are submitted, together with an estimate of cost, to the Bureau of Public Roads for approval, after which the proposed work is advertised, bids received and the contract awarded for construction.

During 1927–1928 biennium surveys have been made and plans drawn up for construction in various counties in the following amounts:

TABLE No. 4

	Surveys (Miles)		Plans (Miles)	
County	*New Construction*	*Reconstruction*	*New Construction*	*Reconstruction*
Churchill	30.90	17.99	23.25	19.27
Clark	41.66	.....	8.66	28.15
Douglas	18.08	2.83	15.61	3.65
Elko	176.84	27.72	.....	25.82
Esmeralda	20.20	.....	52.87	.....
Eureka	.....	.....	.....	.....
Humboldt	.....	30.30	.....	17.41
Lander	.....	8.52	.....	8.52
Lincoln	35.47	.....	15.74	1.70
Lyon	20.65	.....	33.09	.....
Mineral	49.18	.....	55.19	.....
Nye	25.41	.....	0.64	.....
Ormsby	10.51	.....	10.51	.....
Pershing	17.15	22.00	16.73	16.72
Storey	.....	.....	.....	.....
Washoe	.....	3.81	.....	3.81
White Pine	50.31	.....	39.71	16.85
Totals	496.36	113.17	272.00	141.90

Following is to be found in tabular form the mileage and costs of surveys and plans for 1927–1928. The mileage of surveys includes the total length of surveyed lines and is subdivided into new surveys and surveys for reconstruction. Mileage of plans is for the adopted length of line only. This mileage is also divided into plans for new work and those for reconstruction.

TABLE No. 5

	Miles	*Cost per mile*
Surveys		
New construction	496.36	$99.45
Reconstruction	113.17	68.38
Plans		
New construction	272.00	$111.99
Reconstruction	141.90	60.00

A comparative cost of surveys and plans made over rough mountainous country as against those for flatter valley country follows. These results accentuate the necessity of careful selection in routes and locations:

TABLE No. 6

	Mountain		Valley	
	Miles	*Cost per mile*	*Miles*	*Cost per mile*
Surveys	31.55	$231.52	464.81	$90.48
Plans	40.21	183.28	231.79	99.62

Miles of surveys over which plans have not been prepared:

TABLE No. 7

	Miles
Route 1–A—	
Between Schurz and 7.5 miles north of Fallon	24.00
Route 2—	
7 miles north of McGill to Magnusson's	10.55
Route 2–A—	
Carson City to Leeteville	52.52
Route 2–B—	
Wabuska to Towle Ranch	16.07

TABLE NO. 7—*Continued.*

	Miles
Route 3—	
Junction with Route 5 to Goldfield	5.84
12.8 miles east of Hawthorne to Dutch Creek	24.23
Route 5—	
24 miles north of Beatty to junction with Route 3	35.45
Route 6—	
California-Nevada state line to Jean	13.09
Route 7—	
Corn Creek toward Caliente	69.83
Route 8—	
Paradise Hill to McDermitt	48.73
Route 8-A—	
Junction with Route 3 toward Manhattan	29.14
Route 10—	
Mina to Montgomery Pass	34.12
Route 13—	
Junction with Route 24 north toward Wells	32.91
Wells to Nevada-Idaho state line	66.53
Route 15—	
Basalt to Coaldale	22.25
Route 17—	
Virginia City to Dayton	6.51
Route 24—	
South Elko County line to Wendover	53.40
Total	545.17

HIGHWAY RIGHT OF WAY

It is of interest to note that in the course of highway construction the State of Nevada, through its Department of Highways, has acquired

Typical highway right of way prior to clearing.

a total of 14,557.58 acres of land for highway right of way purposes. This acreage is divided into two classes: (1) That acquired from private land owners; and (2) Government land. The acreage through privately owned property amounts to 6,329.79 and through open

OREGON
IDAHO
UTAH
CAL
GREAT SALT LAKE DESERT
To Bend
To Boise
To Twin Falls
To Ogden
To Salt Lake
To Alturas
To Susanville
To Quincy
Denio
McDermitt
Owyhee
Jarbidge
Contact
Cedarville
Alkali Lakes
Quinn Riv. X'ing.
Platora
Paradise
Tuscarora
Midas
Weiland
Halleck
Deeth
Wells
Oasis
Cobre
Montello
S.P.R.R.
O.S.L. R.R.
W.P. R.R.
N.N. R.R.
N.C. R.R.
E.&P. R.R.
S.P. R.R.
Wendover
WINNEMUCCA
Golconda
Sulphur
Gerlach
Humboldt River
Imlay
Valmy
Battle Mt.
Dunphy
Carlin
ELKO
Palisade
Beowawe
Betty O'Neil
Blackburn
Franklin Lake
Ruby Lake
Currie Sta.
Cortez
Ibapah
Tippett
Cherry Creek
Flanigan
Pyramid Lake
Winnemucca Lake
LOVELOCK
Fanning
Wadsworth
Carson Sink
Doyle
Plumas Jct.
Truckee
Boca
Verdi
RENO
Sparks
Virginia City
Fernley
Hazen
FALLON
Salt Wells
Sand Spr's.
Frenchman's
East Gate
CARROLL SUMMIT
AUSTIN
EUREKA
Magnuson's Ranch
McGill
ELY
Ruth
Kimberley
Hamilton
Tahoe
LAKE TAHOE
Emerald Bay
Tallac
Meyers
Dayton
CARSON CITY
MINDEN
Gardnerville
Wellington
Ludwig
Wabuska
Carson Lake
Quartz Mt.
Schurz
Burnt Cabin
Ione
Duckwater
Barnes
Preston
Lund
Currant
Baker
Garrison
Lehman
Connors Pass
1
2
2a
2b
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8a
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40
50
93

STATE OF NEVADA
DEPARTMENT OF HIGHWAYS

HIGHWAY MAP STATE OF NEVADA

SCALE—1/2 in. = 25 mi.

S.C. DURKEE, STATE HIGHWAY ENGR.

1929

Government land 8,257.79. The cash outlay for right of way through private property amounts to $103,105.59, or an average cost of $16.29 per acre. The right of way across Government lands was secured without cost.

During the past biennium it has not been necessary to exercise the State's power of eminent domain in the course of securing rights of way, and although State highways have been constructed across extremely rich agricultural holdings the Department's dealings with the property owners have been most pleasant and agreeable.

Table No. 8 sets forth by routes the acreage acquired, and the costs.

TABLE No. 8

Total Acreage by Routes

	Acres				Cost per Acre	
Route	*Private*	*Public*	*Total*	*Cost*	*Private*	*Total*
1	2,043.13	1,705.92	3,749.05	$54,449.15	$26.65	$14.52
2	237.52	2,578.56	2,816.08	9,855.10	41.49	3.50
3	745.68	1,462.48	2,178.16	24,916.85	33.41	11.44
4	42.08	.....	42.08			
5	2,780.00	.....	2,780.00	3,829.44	1.38	
6	178.92	954.54	1,133.46	3,713.05	20.75	3.28
7	91.72	1,022.01	1,113.73	4,340.00	47.32	3.90
8	121.17	122.61	243.78	171.00	1.41	.70
9	89.57	22.34	111.91	1,831.00	20.44	16.36
17		52.36	52.36			
24		336.97	336.97			
Totals	6,329.79	8,257.79	14,557.58	$103,105.59	$16.29	$7.08

ELIMINATION OF RAILROAD GRADE CROSSINGS

It has been the endeavor of the Department to eliminate crossings of highways and railroads at grade, especially on the heavily traveled highways, and at crossings of the main-line railroads. This is done either by constructing grade separation structures, or by relocating the highway so as to avoid the crossing.

During this biennium three concrete and steel grade separation structures have been built at the following points:

Overhead crossing of the Union Pacific railroad near Jean, Clark County.

Overhead crossing of the Southern Pacific railroad near Fernley, Lyon County.

Underpass crossing of the Western Pacific railroad near Wells, Elko County.

There are now but four grade crossings of the main-line railroads on Route 1 of the State Highway System. These are: Woolsey crossing of the Southern Pacific railroad, and the Dunphy, Deeth and Silver Zone crossings of the Western Pacific railroad. It is proposed to eliminate the Woolsey crossing within the next biennium by constructing an overpass structure. These four crossings are not particularly dangerous as the approaches are in open country and the visibility is good.

All grade crossings of the main line of the Union Pacific railroad on Route 6 of the State Highway System in Clark County have been eliminated.

Grade crossings on the balance of the State Highway System, that have not already been eliminated, are not with main-line railroads; and these crossings have been amply protected by the erection of warning signs and red bull's-eye lights.

TABLE No. 9

Bridges of More Than 20 Foot Clear Span

Type of Construction	Completed 1917–1926 No.	Completed 1917–1926 Length	Completed 1927–1928 No.	Completed 1927–1928 Length	Total No.	Total Length
Reinforced Concrete	17	1,709	1	25	18	1,734
Structural Steel	4	528	--	----	4	528
Timber Bridges and Trestles	5	1,920	--	----	5	1,920
Totals	26	4,157	1	25	27	4,182

REPORT OF THE TESTING DEPARTMENT

Too much stress cannot be laid on the importance and necessity of the testing of materials to be used in highway construction. Testing and research, while still in their infancy, have become a leaning post for the road builder. In this age of mechanical devices, where the

Overhead grade separation structure near Fernley.

best is always in demand, and provision is being made for the future, no roadway construction is begun, no bridges built, no dirt moved, without the attendant report of the materials used therein. The advantages of suitable materials over those of unknown quality have become so widely known that one hundred per cent testing has become practically universal.

In order to stay abreast of the requirements of the Bureau of Public Roads, in assuring the use of suitable material for road construction, small additions to the testing laboratory are continually required. During the biennium of 1927–1928 further equipment and supplies were added, making it possible to conduct complete chemical analyses on most road building materials and additional tests on road oils.

Chemical analyses are now made on corrugated metal pipe culvert sheets, reinforcing steel, Portland cements, paints, soils and water. By the addition of an oil centrifuge to the laboratory's equipment it has now become possible to make all the required tests on road oils and asphalts.

On road products such as cement, corrugated metal pipe, oil and asphalt which are shipped into this State from plants or mills, samples are submitted to, and tests made at, this laboratory prior to shipping,

thus eliminating as far as possible the receipt of unsatisfactory materials. The matter of testing local products is simple but is handled in the same manner. The purposes of the testing department are to insure proper materials and at the same time decrease the delays and inconveniences which might easily result from the requirements of pretesting.

The following table indicates the variety of materials tested and the number of tests made during this biennium. All the tests are made at the laboratory at Carson City with the exception of compression and tension tests on concrete, steel, etc. Through the courtesy of the University of Nevada this department has been given access to the use of two testing machines located in the Mechanical Building of

Approach to grade separation structure near Fernley.

the University at Reno. By means of these two machines the last-mentioned tests have been made possible:

TABLE No. 10

Cement	78
Concrete cylinders	470
Concrete sand	87
Concrete gravel	63
Surfacing material	282
Corrugated metal pipe	361
Steel sheets for corrugated metal pipe	204
Reinforcing steel	90
Crushed rock	23
Oil	188
Asphalt	4
Paint	4
Clay binder	17
Soil	5
Creosoted timber	1
Water analysis	5
Vitrified clay pipe	1
Oiled gravel stain tests	140
Miscellaneous	7
Total	2,030

MAINTENANCE

One of the most important problems facing Nevada is the question of financing the ever increasing cost of maintenance. It is generally understood that maintenance is as important as good construction, and, if a road is not properly maintained, that road deteriorates very rapidly under ordinary traffic.

To date the methods of road maintenance used in Nevada have been very satisfactory for keeping the roads smooth and free from corrugations and other irregularities. Highway transportation, however, has increased to such an extent during the past two years as to demand revolutionary changes in both construction and maintenance methods.

Reconstruction of the main traveled roads is now under way in

Typical underpass grade separation structure.

many parts of the State as a permanent feature of the program developed to overcome the conditions which have made present maintenance methods inadequate and costly.

A very rapid increase in transcontinental travel was noted just prior to the time when it became evident that these changes were necessary. A traffic census taken in 1926 showed an increase in all classes of motor vehicle travel on the main highways, and also showed that 25 per cent of the total number of vehicles using the highways were registered from other States.

Realizing the seriousness of this rapidly increasing traffic load and its relation to the cost of maintenance—and knowing that it would be

illogical to construct the balance of the State Highway System without first taking into consideration the upkeep and restoration needed to make the roads already improved both safe for traffic and economical to maintain—a plan was outlined to develop a program of construction and reconstruction (including oiling) to be carried on simultaneously in order to satisfy the demands for new roads and at the same time improve the serviceability of the State Highway System.

Unfortunately, Nevada was financially unable to hard surface more than a small fraction of the total mileage of improved highways that were carrying an overload of traffic; therefore, the problem was to find and adopt some type of road surface that would be strong enough to meet the demands of the present-day traffic load and still be economical to apply. After considering several different types and methods of surfaces and surfacing, a bituminous treatment, commonly known as the "Bituminous Surface Mixing Method," was adopted.

Bituminous treated crushed gravel surface between Keystone and Ely, in White Pine County.

To the States of Oregon and California is due the credit for pioneering the use of an asphaltic oil for treating crushed gravel and crushed rock surfaces.

The method of applying a 60 to 70 per cent asphaltic fuel oil by the "Surface Mixing Method," so satisfactorily used during this biennium, was developed by the California Highway Commission. The method consists of producing a road surface similar to an asphaltic concrete by first scarifying and smoothing, and then applying the asphaltic fuel oil in three applications, each consisting of approximately one-half gallon to the square yard of surface. After each application the soil is thoroughly mixed with the loose material by means of a disc and spring-tooth harrow worked in tandem. When the oil and road material are completely mixed, this mixture is bladed from the sides of the road to the center. After all the material has been windrowed it is again mixed with the disc and spring-tooth harrow

until the entire mixture is ready for quartering and turning back toward the sides. This process is repeated until the mixture has attained a uniform color. The actual amount of mixing depends upon the character and screen analysis of the material, the viscosity of the oil, and the temperature.

After the mixing has been completed the mixed material is bladed back and forth across the road until a smooth surface has been attained and no streaks of unmixed material are left in the finished surface. To eliminate any possible chance of having any unmixed material on the surface the top inch of the finished surface is again thoroughly mixed and spread. The compaction of the completed surface is done under traffic, and the maximum traffic speed is kept to thirty miles an hour until the surface has become thoroughly compacted.

During the summer of 1927 the Department, working with the approval of the Bureau of Public Roads, made its first experiment

Making first application of asphaltic fuel oil.

with bituminous treatment. The section chosen for this experiment was a newly constructed and uncompacted surface of crushed gravel 4.76 miles long located on the Victory Highway east of Fernley, in Lyon County.

The treatment of this section was applied under many adverse conditions at a cost of about $1,800 a mile. The poor stability of the newly built fills and the character of the fill material, which is a free blow sand, made it necessary to perform all the operations, such as mixing, spreading, and compacting, in the center of the roadway. This retarded the progress to a great extent and caused the costs to increase over the amount estimated for the work.

This section proved satisfactory in every way, and furnished the Department with sufficient data to insure a substantial reduction in surface maintenance costs, and an annual saving of from $150 to $300 per mile of treated surface on binder and gravel loss. During the first ten months after this section was opened to traffic, less than $10 a mile was spent for surface maintenance. Since the completion of this

section it has been under constant observation and at present the surface appears to be in better condition than ever. Even after the 1928 summer traffic load of 300 cars a day there has been but a slight indication of wear.

At the present time it is very hard to give a fair estimate covering the cost of maintenance on this type of surface, but if the work done this year stands up to the expectations of the Department, which are based solely upon the results obtained from the experimental section, surface maintenance should not exceed $100 a mile.

The past season's work in the use of an asphaltic fuel oil for a binder has brought forth many interesting problems, the solution of which has been more or less determined by experimentation. The one most difficult to determine has been the need of using more bituminous material than the theoretical amount called for. On certain sections

Preparing for final application of asphaltic fuel oil.

treated, the theoretical amount appeared to be right. On other sections, where the grading and the character of the material were almost identical, it was necessary to use from 10 to 20 per cent more bituminous material than the formula of the theoretical amount called for. Wide variations in grading caused by segregation after the surfacing material has been placed, the characteristics of the material, the amount and time of mixing, and other factors have all been taken into consideration in trying to solve this problem. Because of the results obtained during the past season, the Department feels assured that the bituminous treatment of Nevada's surfaced roads is the economical solution to relieve the dust nuisance and the loose gravel hazard, and it is believed that this method will increase the serviceableness of the State Highway System in an inestimable amount.

For maintenance and engineering purposes the State is divided into four engineering divisions with division headquarters, maintenance repair shop and yard as near the center of the territory covered by the division as possible. The highway system in each district is divided into sections varying from 10 to 60 miles in length, depending upon

the type of road and the volume of traffic. Each division is in charge of a division engineer who is directly responsible for the proper maintenance of all the roads on the State Highway System within his division.

The maintenance department operates on a definite budget which is made in November of each year in accordance with the recommendations of the division engineer. After approval, the budget governs the following year's maintenance expenditures on each section of road. As a result of the past ten years' experience, the cost of maintaining each type of road has become more or less standardized. Each year's maintenance budget is based on the known costs plus an allowance for any necessary betterment work which may be done by maintenance forces. The climatic conditions, the age of the surfacing, and the traffic load are given due consideration in recommending expenditures under the budget system.

General maintenance covers numerous operations which are directly

Mixing by turning the treated material from the edge to the center of the road.

responsible for keeping material and other road losses to a minimum as well as for the promotion of safety. Certain types of roads and various traffic conditions warrant specific maintenance operations; for example, on a road surfaced with cement concrete one of the main operations is keeping the shoulders built up to support the edges of the pavement to keep them from breaking. Other important operations are filling expansion joints and cracks, removing slides, clearing snow, and cleaning ditches and culverts.

On a gravel surfaced road the major operations are dragging, raking rocks, replacing surface losses, and cleaning ditches and culverts.

During the fiscal year 1927, $343,399.28 was spent for maintaining 1,445.08 miles of road. This total mileage includes improved, semi-improved and unimproved types of road. The total cost includes all direct and indirect charges to maintenance, also the maintenance and depreciation on the equipment used. The mileage and expenditures are divided as follows:

TABLE No. 11

Type	*Mileage*	*Expenditures*
Concrete	40.95	$27,493.41
Asphalt macadam	20.56	7,768.89
Oiled sand	10.05	601.05
Gravel	1,035.00	262,997.76
Improved	99.51	17,947.56
Semi-improved	172.21	24,429.72
Unimproved	60.00	510.38
Prison road	1.80	274.96
Operating magnet truck	.....	1,375.55
Total	1,445.08	$343,399.28

The improved type of road embraces the roads which have been graded and surfaced by maintenance forces.

Semi-improved roads are those which have been partly improved by the maintenance forces.

Unimproved includes all roads which have not been graded or improved to any extent other than by general maintenance.

The $274.96 expenditure for prison road represents the cost borne

Finished surface of bituminous treated crushed gravel prior to completion.

by the maintenance department for setting up and installing a rock crushing and screening plant used by the Prison Commissioners for surfacing the road from Carson City to the prison.

The $1,375.55 was expended for operating the magnetic truck used for removing nails and other metallic objects from the highways.

The cost per mile for maintaining the various types was:

TABLE No. 12

Type	*Total miles*	*Total expenditure*	*Cost per mile*
Concrete	45.95	$27,493.41	$598.33
*Gravel	918.23	253,745.32	276.34
Asphalt macadam	20.56	7,768.89	377.83
Oiled sand	10.05	601.05	59.81
Improved	99.51	17,947.56	180.36
Semi-improved	172.21	24,429.72	141.86
Unimproved	60.00	510.38	8.51
Totals	1,326.51	$332,496.33	$250.66

*A total of 1,035.00 miles of gravel roads was maintained during the year, but only 918.23 miles received a full year's maintenance. The remaining 116.77 miles were under construction and were taken over by the maintenance department when completed; therefore, to obtain the correct cost per mile, the total 918.23 is used as a base.

The figures shown for the cost per mile for maintaining unimproved roads are not reliable for the reason that only a few short sections of the 60 miles of this type, under maintenance supervision, were maintained to any extent.

Table No. 13 shows the expenditures made for the different maintenance operations on concrete, asphalt macadam and oiled sand roads.

TABLE No. 13

Operation	Concrete	Per cent	Asphalt macadam	Per cent	Oiled sand	Per cent
Maintaining shoulders	$6,595.41	24.0	$2,650.46	34.1	$327.26	54.5
Filling expansion joints and cracks	4,733.34	17.2				
Cleaning culverts and ditches	1,982.83	7.2	1,639.09	21.1		
Cutting weeds and brush	909.72	3.3	416.77	5.4		
Patching surface	16.55	.1	664.30	8.6		
Removing slides and trimming slopes	3,811.84	13.9	828.66	10.7		
Repairing washouts	2,006.14	7.3	336.67	4.3	21.67	3.6
Removing snow	4,617.74	16.8	8.00	.1		
Repairing guard rail	886.88	3.2	434.79	5.6		
Protecting slopes and riprapping	6.00					
Painting (General)	84.85	.3	40.50	.5		
Building and repairing bridges and culverts	33.00	.1	350.28	4.5		
Painting traffic center line	393.68	1.4				
Administration	1,415.43	5.2	399.37	5.1	30.04	5.0
Dragging					222.08	36.9
Totals	$27,493.41		$7,768.89		$601.05	

The expenditure of $222.08 for dragging the oiled sand road was made on a short stretch where the oiled sand had become loosened and the wheels of passing vehicles had caused it to rut.

The expenditures on the other types of road are clearly analyzed in Table No. 14.

TABLE No. 14

Operation	Gravel	Per cent	Improved	Per cent	Semi-improved	Per cent	Unimproved	Per cent
Cleaning culverts, ditches	$7,914.60	3.1	$169.13	.9	$123.02	.5		
Cutting weeds and brush	2,561.24	1.0						
Dragging	159,212.39	62.7	10,426.10	58.1	15,514.93	63.5	$423.12	82.9
Sprinkling	1,527.97	.6						
Raking rocks	10,378.79	4.1	1,171.82	6.5	2,896.99	11.9	10.00	2.0
Removing slides and trimming slopes	1,933.48	.8	88.06	.5	53.35	.2		
Washouts	12,518.80	4.9	935.35	5.2	1,329.60	5.4		
Surfacing	35,602.13	14.0	3,766.58	21.0	2,378.42	9.7	50.75	9.9
Removing snow	3,553.25	1.4	49.96	.3				
Guard rail	1,683.03	.7	263.62	1.5				
Protecting slopes	168.09	.1	45.00	.2				
Painting	1,415.52	.6	64.02	.4	39.62	.2		
Repairing bridges, culverts	2,220.78	.9	45.50	.3	835.61	3.4		
Administration	13,055.25	5.1	922.42	5.1	1,258.18	5.2	26.51	5.2
Totals	$253,745.32		$17,947.56		$24,429.72		$510.38	

Table No. 15 shows the mileage maintained and the expenditures in each county.

TABLE No. 15

County	*Mileage*	*Expenditures*
Churchill	113.52	$21,414.60
Clark	166.63	43,641.54
Douglas	30.93	9,642.60
Elko	138.38	42,564.55
Esmeralda	85.46	5,164.31
Eureka	63.02	13,634.57
Humboldt	81.09	18,292.73
Lander	125.90	16,218.16
Lincoln	63.75	17,071.84
Lyon	50.65	15,226.05
Mineral	35.56	7,072.88
Nye	205.35	35,373.88
Ormsby	5.77	1,179.95
Pershing	74.90	19,722.11
Storey	5.40	1,283.07
Washoe	84.87	43,562.05
White Pine	113.90	30,958.84
	1,445.08	$342,023.73
Operating magnet truck		1,375.55
		$343,399.28

During the fiscal year ending November 30, 1928, $359,262.08 was spent for maintaining 1,680.73 miles of road. The total mileage includes improved, semi-improved and unimproved types of road. The total cost includes all direct and indirect charges to maintenance, also equipment rentals and $2,706.75 for signing. The mileage and expenditures are divided as follows:

TABLE No. 16

Type of road	*Mileage*	*Expenditures*
Concrete	45.95	$20,616.98
Asphalt macadam	20.56	6,902.30
Bituminous treated surface	14.92	614.82
Gravel	1,173.28	288,605.28
Improved	269.74	36,201.14
Unimproved	152.22	2,853.55
Repairing bridge		179.52
Operating magnets		96.35
Maintaining forest highway	4.06	486.09
	1,680.73	$356,556.03

During the year 1928, 106.74 miles of gravel surfaced highway were bituminous treated. This treatment was applied late in the year, consequently the maintenance costs for the balance of the year were negligible and have been charged directly to the gravel surfaced type road.

The expenditure of $179.52 represents the cost to date of repairing the bridge across the Humboldt River at Dunphy, in Eureka County.

$96.35 was spent for operating the magnet truck used for removing nails and metallic objects from the highways.

$486.09 was expended for maintaining 4.06 miles of forest highway in White Pine County for which the Department is to be reimbursed by the Government.

The cost per mile for maintaining the various types is as follows:

TABLE No. 17

Type of surface	*Miles*	*Cost*	*Cost per mile*
Concrete	45.95	$20,616.98	$448.68
Asphalt macadam	20.56	6,902.30	335.71
Bituminous treated surface	14.92	614.82	41.21
*Gravel	1,025.27	288,605.28	281.49
Improved	269.74	36,201.14	134.21
Unimproved	152.22	2,853.55	18.75
Totals	1,528.66	$355,794.07	$232.75

*1,173.28 miles of gravel roads were maintained during the year, but only 1,025.27 miles received a full year's maintenance. The remaining 148.01 miles were under construction and were taken over for maintenance when completed. In arriving at the cost per mile 1,025.27 is used.

Table No. 18 shows the expenditures made for the different maintenance operations on concrete, asphalt macadam and bituminous treated roads:

TABLE No. 18

Operation	Concrete	Per cent	Asphalt macadam	Per cent	Bituminous treated	Per cent
Maintaining shoulders	$7,136.60	34.6	$2,780.37	40.3	$42.63	6.9
Filling expansion joints and cracks	2,828.95	13.7				
Cleaning culverts and ditches	3,330.45	16.2	2,065.40	29.9		
Cutting weeds and brush	747.18	3.6	67.99	1.0		
Patching surface	116.79	.6	1,394.89	20.2	511.58	83.2
Removing slides and trimming slopes	3,383.59	16.4	164.17	2.4		
Repairing washouts	258.17	1.3	77.00	1.1		
Removing snow	695.19	3.4	102.80	1.5		
Protecting guard rail	485.25	2.4	25.19	.4		
Protecting slopes and riprapping	52.36	.2				
Painting (General)			36.00	.5		
Building and repairing bridges and culverts	498.94	2.4			46.23	7.5
Painting traffic center line	520.51	2.5				
Surfacing					14.38	2.4
Administration	563.00	2.7	188.49	2.7		
Totals	$20,616.98		$6,902.30		$614.82	

The expenditures on the other types of roads are analyzed in Table No. 19:

TABLE No. 19

Operation	Gravel	Per cent	Improved	Per cent	Unimproved	Per cent
Maintaining shoulders	$1,072.49	.4				
Cleaning culverts and ditches	9,168.82	3.2	$275.27	.8		
Cutting weeds and brush	1,578.90	.5	1,196.74	3.3		
Dragging	215,856.70	74.8	25,524.80	70.5	$2,815.22	98.7
Sprinkling	1,414.00	.5				
Raking rocks	8,668.31	3.0	1,687.98	4.7		
Removing slides and trimming slopes	3,078.95	1.1	14.75			
Washouts	3,094.52	1.1	132.34	.4	4.55	.1
Surfacing	31,176.75	10.8	4,791.50	13.2	22.74	.8
Removing snow	2,265.09	.8	104.42	.3		
Protecting guard rail	942.73	.3	2.67			
Protecting slopes and riprapping	567.81	.2				
Painting (General)	656.29	.2	25.68	.1		
Building and repairing bridges and culverts	1,194.50	.4	1,458.01	4.0		
Administration	7,869.42	2.7	986.98	2.7	11.04	.4
Totals	$288,605.28		$36,201.14		$2,853.55	

Table No. 20 shows the mileage maintained and the expenditures in each county:

TABLE No. 20

County	*Mileage*	*Expenditures*
Churchill	112.50	$24,349.54
Clark	167.28	38,661.96
Douglas	43.92	7,959.34
Elko	138.38	42,822.96
Esmeralda	131.13	5,847.47
Eureka	72.70	18,248.56
Humboldt	81.09	19,321.29
Lander	125.90	32,041.23
Lincoln	79.49	12,106.69
Lyon	67.29	25,739.85
Mineral	74.37	9,029.00
Nye	275.04	32,663.64
Ormsby	14.47	2,354.26
Pershing	74.90	21,467.16
Storey	5.40	479.77
Washoe	84.92	32,302.92
White Pine	127.89	30,577.95
	1,676.67	$355,973.59
Forest highway in White Pine County	4.06	486.09
Operating magnets	.....	96.35
	1,680.73	$356,556.03
Signing	.....	2,706.05
		$359,262.08

DISPLAY AND ERECTION OF U. S. ROAD MARKERS AND SIGNS

During the biennium the erection of U. S. standard road markers and warning signs has practically been completed on U. S. Routes 40, 50, and 91.

The standard U. S. road markers erected bear the name of the State, the number of the route, and the letters U. S., with the design and lettering in black on a white background. These markers are set facing and on the right-hand side of approaching traffic for the purpose of directing traffic over specific routes. The markers, as a rule, have been erected from fifty to seventy-five feet beyond the intersection of each important crossroad and side road in order to pull the traffic beyond the point of intersection; and in all cases they have been placed far enough from the side to be safe from traffic coming into the highway from such roads.

On open roads, such as most of the roads in this State, where very few intersections occur, one marker has been erected for each traffic lane for the total tangent distance where the tangent distance has not exceeded five miles.

The warning signs that have been adopted comprise a standard set of signs of a precautionary character which cover a large variety of conditions that it is necessary to guard against in the interest of safety. This series includes the circular railroad sign, octagonal stop sign, diamond slow and curve directional signs, and square caution sign. The symbols used show railroad grade crossings, both single and multiple tracks, left and right curves and turns, reverse curves and turns, stop, slow, danger, etc., with the designs and lettering in black on a yellow background. The information and restriction signs have black

designs and lettering on a white background. The use of these signs has been kept to a minimum consistent with a certain degree of safety, as too frequent use of such signs tends to create a disregard for them. In erecting these signs a minimum separating distance of 100 feet has been used where possible. Where it has been necessary for both warning signs and route markers, at approximately the same location, the warning signs have been given preference. In all cases the location of these signs has been governed by the topography of the adjacent country, traffic density and traffic conditions so as to afford the greatest protection possible. The location of railroad grade crossing signs is governed by the visibility of the point in danger and the average traffic speed at this point. If the location is on a long straight road in open country and on a down grade, the maximum distance of 500 feet from the railroad track is used. Where the location is in a built up district and on a curve, which will result in traffic moving slowly, the minimum distance of 250 feet is usually allowed.

Slow signs are erected as a general rule to protect against sharp curves and steep grades, and are located on the outside edge of the road with the sign directly facing the approaching traffic. In a mountainous country where the tangent distance between curves is very short, a warning sign is used at each end of such a section in addition to the slow signs. These signs warn against the type of road ahead, such as "Five Miles of Steep Grades and Sharp Curves," or any other information necessary to protection, and are only used for the most dangerous conditions.

Curve signs bearing the symbols designating the direction are used on curves having 150 to 1,000 foot radius and are placed from 150 to 300 feet from the beginning of the curve.

Cattle-crossing signs are placed to protect against road intersections and property roads leading off the highway where it is the practice of the inhabitants to drive stock across the highway. These signs are placed either 400 or 500 feet from the danger point, as indicated on the sign.

The school sign is one of the most important and is erected at points along the highway where a schoolhouse and grounds are adjacent. These signs are located 500 feet from the entrance to the school grounds.

Under ordinary circumstances the center of the sign is placed approximately five feet above the shoulder line of the road, with a slight variation for ascending and descending grades, or for improving visibility.

This work has been done under the System of Standardized Signs and Markers, as adopted by the American Association of State Highway Officials, and is based on certain principles to produce uniformity so as to enable the most casual driver to become familiar with the various conditions covered by the information as outlined on each distinctive sign and marker.

ANNUAL TRAFFIC COUNT

The density and type of traffic on the highway system justifies the expenditure of public funds for construction and maintenance purposes. To determine the necessary improvements and replacements to

accommodate the present and future volume of traffic it is essential to have a certain amount of accurate and comprehensive information relative to the various types of vehicles using the State highways. To obtain this information a traffic survey has been made each year since 1922.

During the first survey, traffic data were recorded at three traffic count stations. Since then 45 stations have been established along the highway system. This increase over a period of six years has been a natural one and is in proportion to the increase in improved highways.

The census is classified as to type of vehicle; *i. e.,* trucks and busses, foreign cars (cars registered from other States and countries), Nevada cars, motorcycles and horse-drawn vehicles. The count is recorded during a week in July and is based on the number of each class of vehicle passing the stations during a 16-hour period from 6 a. m. to 10 p. m.

This year one 24-hour count was made at a station located on the Arrowhead Trail, 3 miles west of Las Vegas, for the purpose of determining the number of vehicles using the highway between 10 p. m. and 6 a. m. The daily average for this period amounted to 22.6 per cent of the total traffic checked during the 24-hour period. The arid climatic conditions in Clark County no doubt account for the large amount of night travel; but, nevertheless, a fair estimate will show that at least 15 per cent of the total volume of summer traffic over the State Highway System occurs between midnight and sunrise.

There is a wide variation in the amount of travel in different parts of the State—a condition due, of course, to the density of population and class of road. This variation has been noticeable in the general maintenance costs as well as in the life of the roads. A comparative study of the traffic count of 1928 on the various highway routes shows the following:

On the Arrowhead Trail, U. S. Route 91, there has been over 100 per cent increase in all classes of motor vehicle travel during the past two years. The largest increase noted was 153.8 per cent in foreign cars.

On the Lincoln Highway, U. S. Route 50, between Hazen and Keystone, there was a traffic decrease varying from 12.8 per cent to 26.1 per cent. This was due to the completion of the Victory Highway. For the same period there was an increase of 35.2 per cent on the section of the Lincoln Highway between Keystone and Ely, and an increase of 65.6 per cent between Ely and Ruth. Another large increase in this district was between Ely and McGill.

Travel over the Midland Trail from Ely south towards Tonopah increased 36.8 per cent, while the travel from Tonopah north towards Ely decreased 5.7 per cent. This wide variation was due to local travel in the vicinity of the traffic count stations, and cannot be used as a true statement of the traffic load between Ely and Tonopah. A further analysis of the traffic census (aside from the local travel) shows a slight variation in all other classes of vehicle travel at these points.

On the roads leading to Reno the increase was normal with the exception of the Reno-Verdi road. On this section there was an increase of 12.2 per cent. However, traffic on the Reno-Verdi road during 1927, the year of Nevada's Transcontinental Highways Exposition, was less than that recorded in 1926.

Another large increase was noted between Gardnerville and Minden and from Minden to Carson City. The newly constructed gravel-surfaced highway from Carson south towards Minden, and the new improvements south of Gardnerville account for the increase on this section.

Since the last traffic census was taken approximately 110 miles of gravel surfaced highway have been oil treated. As a result the 1929 census will undoubtedly prove the road users' appreciation by showing a larger increase in all types of vehicle traffic than has ever been recorded.

With the knowledge of these various increases and decreases in the volume of traffic, the Department can accurately account for the life and condition of the highways, as well as estimate the cost of maintaining each section; and formulate plans for reconstruction and other corrective work.

Table No. 21 shows the complete tabulation of the traffic census as recorded since the first count was made. The per cent increase or decrease shown is for comparison between the years 1928 and 1927. The letters "M. and H. D.," in the tabulation refer to motorcycles and horse-drawn vehicles.

TABLE No. 21

ROUTE 1

	1928 daily Average	*1927 daily Average*	*1926 daily Average*	*1925 daily Average*	*1924 daily Average*	*1923 daily Average*	*1922 daily Average*	*Per cent increase or decrease over 1927*
Reno-Verdi—								
Total vehicles	1993	1777	1852	1601	700	.....	.....	*12.2
Trucks and busses	132	90	218	121	35			
Foreign cars	801	762	477	365	170			
Nevada cars	1051	913	1122	1065	472			
M. and H. D.	9	12	35	50	23			
Reno-Sparks—								
Total vehicles	3797	3532	2832	3286	2809	2235	1626	*7.5
Trucks and busses	488	203	366	233	199	171	95	
Foreign cars	780	846	502	593	357	247	87	
Nevada cars	2487	2460	1933	2436	2204	1759	1402	
M. and H. D.	42	23	31	24	49	58	42	
East city limits Sparks—								
Total vehicles	553							
Trucks and busses	38							
Foreign cars	287							
Nevada cars	224							
M. and H. D.	4							
Fernley-Junction on Victory Highway—								
Total vehicles	309	258	153	75	53	56	.....	*19.8
Trucks and busses	14	15	2	1	2	1		
Foreign cars	231	164	133	57	38	40		
Nevada cars	62	78	17	15	13	13		
M. and H. D.	2	1	1	2	0	2		
One-half mile south of Winnemucca—								
Total vehicles	418	361	295	204	160	189	.....	*15.8
Trucks and busses	25	13	8	8	8	15		
Foreign cars	261	203	141	64	43	50		
Nevada cars	130	143	144	130	108	122		
M. and H. D.	2	2	2	2	1	2		
One mile west of Battle Mountain—								
Total vehicles	318	245	196	.....	75	.....	.....	*29.8
Trucks and busses	15	9	3	.....	5			
Foreign cars	227	185	132	.....	19			
Nevada cars	73	49	57	.....	50			
M. and H. D.	3	2	4	.....	1			
One-half mile west of Elko—								
Total vehicles	438	329	341	299	289	149	.....	*33.1
Trucks and busses	21	4	18	54	19	10		
Foreign cars	261	189	156	57	49	42		
Nevada cars	154	135	164	185	219	94		
M. and H. D.	2	1	2	3	2	3		

*Increase. †Decrease.

TABLE NO. 21—*Continued.*

	1928 daily Average	1927 daily Average	1926 daily Average	1925 daily Average	1924 daily Average	1923 daily Average	1922 daily Average	Per cent increase or decrease over 1927
One mile east of Deeth—								
Total vehicles	367	307	.....	.....	.....	.....	.....	*19.5
Trucks and busses	23	10						
Foreign cars	236	197						
Nevada cars	106	98						
M. and H. D.	2	2						
Two miles east of Wells—								
Total vehicles	244	230	.....	.....	.....	.....	.....	*6.1
Trucks and busses	9	5						
Foreign cars	201	192						
Nevada cars	32	33						
M. and H. D.	2	0						
ROUTES 1 AND 2								
Junction Victory and Lincoln Highway—								
Total vehicles	590	490	.....	.....	.....	.....	.....	*20.4
Trucks and busses	42	35						
Foreign cars	307	269						
Nevada cars	239	184						
M. and H. D.	2	2						
ROUTE 2								
One-half mile east of Fernley—								
Total vehicles	281							
Trucks and busses	28							
Foreign cars	76							
Nevada cars	177							
M. and H. D.	0							
Leeteville-Lincoln Highway—								
Total vehicles	205	235	172	141	149	128	.....	†12.8
Trucks and busses	21	22	12	8	9	5		
Foreign cars	53	65	34	43	36	32		
Nevada cars	130	146	125	89	102	88		
M. and H. D.	1	2	1	2	2	3		
Three miles west of Hazen—								
Total vehicles	176	222	.....	.....	.....	.....	.....	†20.7
Trucks and busses	21	22						
Foreign cars	56	61						
Nevada cars	99	137						
M. and H. D.	0	2						
Salt Wells—								
Total vehicles	85	102	98	82	72	61	.....	†16.7
Trucks and busses	13	21	19	12	12	5		
Foreign cars	28	40	26	32	30	35		
Nevada cars	44	40	53	37	31	21		
M. and H. D.	0	1	0	1	2	0		
One-fourth mile east of Austin—								
Total vehicles	68	92	106	83	58	210	.....	†26.1
Trucks and busses	1	5	6	9	4	16		
Foreign cars	28	46	31	38	26	58		
Nevada cars	38	40	68	35	28	116		
M. and H. D.	1	1	1	1	0	20		
Ely to Eureka at Keystone—								
Total vehicles	99	99	110	99	413	313	.....	0.0
Trucks and busses	20	9	18	7	54	43		
Foreign cars	30	29	33	40	62	56		
Nevada cars	48	61	58	51	293	196		
M. and H. D.	1	0	1	1	4	18		
Ely to Keystone—								
Total vehicles	737	545	526	515	.....	.....	.....	*35.2
Trucks and busses	83	55	75	64				
Foreign cars	116	71	74	121				
Nevada cars	537	419	396	325				
M. and H. D.	1	0	1	5				
Ely to Ruth at Keystone—								
Total vehicles	738	446	416	416	.....	.....	.....	*65.5
Trucks and busses	63	46	57	57				
Foreign cars	86	42	41	81				
Nevada cars	489	358	318	274				
M. and H. D.	0	0	0	4				
Ely-McGill—								
Total vehicles	631	450	657	435	346	.....	.....	*40.2
Trucks and busses	101	32	105	82	39			
Foreign cars	77	70	69	51	59			
Nevada cars	450	346	480	300	245			
M. and H. D.	3	2	3	3	3			

*Increase. †Decrease.

TABLE No. 21—*Continued.*

ROUTE 3

	1928 daily Average	*1927 daily Average*	*1926 daily Average*	*1925 daily Average*	*1924 daily Average*	*1923 daily Average*	*1922 daily Average*	*Per cent increase or decrease over 1927*
Reno-Carson at Moana—								
Total vehicles	2302	2104	1876	1808	2202	1825	1270	*9.4
Trucks and busses	109	106	74	25	123	54	57	
Foreign cars	496	583	338	341	282	247	92	
Nevada cars	1683	1395	1454	1431	1759	1493	1075	
M. and H. D.	14	20	10	11	38	32	46	
Reno-Carson to Moana—								
Total vehicles	530	741	345	404	.....	.....	.....	†28.5
Trucks and busses	15	30	7	1				
Foreign cars	82	194	45	51				
Nevada cars	431	510	291	350				
M. and H. D.	2	7	2	2				
Reno-Carson at Geiger Grade—								
Total vehicles	1200	1135	848	.....	.....	.....	.....	*5.7
Trucks and busses	56	50	36					
Foreign cars	332	373	215					
Nevada cars	803	706	594					
M. and H. D.	9	6	3					
Junction Reno-Carson to Virginia City Road-Geiger Grade—								
Total vehicles	99	103	123	85	.....	.....	.....	†3.9
Trucks and busses	8	6	7	11				
Foreign cars	24	19	21	17				
Nevada cars	65	76	95	56				
M. and H. D.	2	2	0	1				
Carson-Reno Junction of Springs Road—								
Total vehicles	1026	955	.....	637	.....	.....	.....	*7.4
Trucks and busses	60	40	.....	29				
Foreign cars	242	302	.....	155				
Nevada cars	721	607	.....	446				
M. and H. D.	3	6	.....	7				
Carson-Minden—								
Total vehicles	552	456	321	255	231	.....	.....	*21.1
Trucks and busses	48	29	21	9	12			
Foreign cars	142	147	89	69	51			
Nevada cars	358	280	209	175	160			
M. and H. D.	4	0	2	2	8			
Gardnerville-Minden—								
Total vehicles	1304	1036	1002	832	908	853	750	*25.9
Trucks and busses	131	95	148	86	78	62	89	
Foreign cars	241	252	184	173	122	156	51	
Nevada cars	917	684	656	561	686	603	561	
M. and H. D.	15	5	14	12	22	32	49	
Gardnerville-Yerington at Holbrook—								
Total vehicles	243	254	.....	.....	104	.....	.....	†4.3
Trucks and busses	18	18	.....	.....	21			
Foreign cars	145	168	.....	.....	44			
Nevada cars	80	66	.....	.....	39			
M. and H. D.	0	2	.....	.....	0			
Topaz Road—								
Total vehicles	147							
Trucks and busses	11							
Foreign cars	118							
Nevada cars	18							
M. and H. D.	0							
One mile east of Yerington—								
Total vehicles	205	195	.....	.....	.....	.....	.....	*5.1
Trucks and busses	36	34						
Foreign cars	12	12						
Nevada cars	153	145						
M. and H. D.	4	4						
West Walker Lake—								
Total vehicles	35	28	59	46	28	31	.....	*25.0
Trucks and busses	2	1	3	3	2	4		
Foreign cars	8	6	15	14	3	6		
Nevada cars	24	20	41	29	21	21		
M. and H. D.	1	1	0	1	2	0		
Tonopah-Goldfield—								
Total vehicles	392	397	208	207	133	184	.....	†1.3
Trucks and busses	30	30	14	5	1	10		
Foreign cars	36	43	19	29	12	17		
Nevada cars	322	318	175	173	120	152		
M. and H. D.	4	6	0	1	0	5		

*Increase. †Decrease.

TABLE No. 21—*Continued.*

ROUTE 3-A

	1928 daily Average	*1927 daily Average*	*1926 daily Average*	*1925 daily Average*	*1924 daily Average*	*1923 daily Average*	*1922 daily Average*	*Per cent increase or decrease over 1927*
Leeteville to Carson—								
Total vehicles	63	61	75	80	71	49	.....	*3.3
Trucks and busses	3	3	4	4	4	2		
Foreign cars	7	11	14	20	19	10		
Nevada cars	53	46	56	55	46	37		
M. and H. D.	0	1	1	1	2	0		
Carson City-Lake Tahoe at Walsh's Ranch—								
Total vehicles	248	311	291	270	201	213	.....	†20.3
Trucks and busses	20	31	9	34	8	2		
Foreign cars	118	163	113	93	87	101		
Nevada cars	108	113	167	138	104	92		
M. and H. D.	2	4	2	5	2	18		

ROUTE 4

North Tonopah to Ely—								
Total vehicles	166	176	82	123	99	85	.....	†5.7
Trucks and busses	21	21	6	12	7	12		
Foreign cars	18	19	9	18	13	16		
Nevada cars	126	136	67	93	78	57		
M. and H. D.	1	0	0	0	1	0		
Ely to Tonopah—								
Total vehicles	286	209	160	226	134	127	.....	*36.8
Trucks and busses	38	52	34	31	29	38		
Foreign cars	26	17	12	25	25	20		
Nevada cars	220	138	110	160	77	63		
M. and H. D.	2	2	4	9	3	6		
Ely to Connors—								
Total vehicles	239	227	145	154	166	28	.....	*5.3
Trucks and busses	36	39	23	17	28	12		
Foreign cars	33	24	18	41	30	11		
Nevada cars	170	163	103	95	103	5		
M. and H. D.	0	1	1	2	5	0		

ROUTE 5

Indian Springs north Las Vegas—								
Total vehicles	25	24	13	.....	.....	.....	.....	*4.2
Trucks and busses	7	6	3					
Foreign cars	6	9	3					
Nevada cars	12	9	7					
M. and H. D.	0	0	0					

ROUTE 6

Three miles west of Las Vegas—								
Total vehicles	‡584	371	266	.....	.....	.....	.....	*57.4
Trucks and busses	59	47	25					
Foreign cars	236	128	93					
Nevada cars	288	194	146					
M. and H. D.	1	2	2					
Glendale—								
Total vehicles	326	222	.....	.....	.....	.....	.....	*46.8
Trucks and busses	38	21						
Foreign cars	173	153						
Nevada cars	113	46						
M. and H. D.	2	2						

ROUTE 7

One-half mile south of Pioche—								
Total vehicles	127	142	129	.....	.....	.....	.....	†10.6
Trucks and busses	13	17	18					
Foreign cars	14	17	18					
Nevada cars	98	108	92					
M. and H. D.	2	0	1					
Ely to Pioche at Geyser—								
Total vehicles	28	20	.....	.....	.....	.....	.....	*40.0
Trucks and busses	3	5						
Foreign cars	10	3						
Nevada cars	15	12						
M. and H. D.	0	0						

ROUTE 8

Four miles north of Winnemucca—								
Total vehicles	126	148	.....	102	79	171	.....	†14.9
Trucks and busses	17	19	.....	10	10	31		
Foreign cars	11	21	.....	16	9	19		
Nevada cars	98	108	.....	76	58	109		
M. and H. D.	0	0	.....	0	2	12		

*Increase. †Decrease. ‡24-hour check shows daily average of 132 vehicles using the highway between 10 p. m. and 6 a. m. or 22.60 per cent of the total traffic.

TABLE NO. 21—*Continued.*

	1928 daily Average	*1927 daily Average*	*1926 daily Average*	*1925 daily Average*	*1924 daily Average*	*1923 daily Average*	*1922 daily Average*	*Per cent increase or decrease over 1927*
Six miles east of Tonopah to Manhattan—								
Total vehicles	143	104	88	.....	.....	.....	.....	*37.5
Trucks and busses	12	8	7					
Foreign cars	24	12	6					
Nevada cars	106	83	75					
M. and H. D.	1	1	0					
			ROUTE 9					
Reno-Purdy—								
Total vehicles	585	471	605	565	533	.....	.....	*24.2
Trucks and busses	25	29	21	28	38			
Foreign cars	194	181	172	170	115			
Nevada cars	358	260	408	362	372			
M. and H. D.	8	1	4	5	8			
			ROUTE 13					
Two miles north of Wells—								
Total vehicles	51	68	.....	.....	.....	.....	.....	†25.0
Trucks and busses	2	2						
Foreign cars	37	31						
Nevada cars	11	31						
M. and H. D.	1	4						

*Increase. †Decrease.

NOTE—Except as noted, all figures shown in this report are for a sixteen-hour count only, covering the period from 6 a. m. until 10 p. m.

EQUIPMENT DIVISION

During the years prior to 1928 the maintenance and construction departments of each engineering division controlled the activities and were responsible for the operation, maintenance and depreciation of all equipment incidental to the construction and maintenance of the State highways. This method resulted in needless confusion; and erroneous book values were placed on the equipment due to each department's using a different rate of depreciation. Furthermore, the location of the equipment was known only to the head of the department under whose jurisdiction it was placed.

Under this system no provision was made for the retirement or replacement of worn-out and obsolete equipment, and instead of prorating the cost of repairs and general maintenance of equipment to the various jobs, the job on which the equipment was working was charged for all repairs and breakdowns. The fallacy of this system can be seen by the following illustration: A truck, in good condition, is employed on a certain job. This job, when finished, releases the truck to another job, and so on, until the same truck has worked on four or five different jobs before a general breakdown comes. When this occurs the job on which it is then working is charged for the total cost of restoring it to its original working condition because the other jobs have been completed and the final reports have been made and the authorization closed. The breakdown may not occur for a year or two. All of the jobs have contributed to the truck's breakdown, yet only one job, the last, is charged for the cost of repairs.

After careful consideration of the many-sided problem it was decided that the original purpose for an equipment division was to place the control of the various related activities—such as the purchase, distribution, and maintenance of all equipment necessary to constructing, improving and maintaining the State Highway System—under one department head. In accordance with this decision a new system was evolved and established in April, 1928. Under this new

system the equipment division, in charge of an equipment superintendent, was placed in direct charge of all state-owned equipment and supplies. At the same time a new method of accounting was perfected to overcome the different rates of depreciation that had been in use. This new method includes a set rental with the rates so arranged as to create a reserve fund for the purchase of new equipment to replace the worn-out and obsolete.

On this basis all equipment is rented to the engineering divisions of the Department with the rates fixed to cover the costs of repairs, replacements and depreciation, and also the administration expenses of the equipment division.

Rentals are reported on an equipment rental payroll by each division engineer, which is prepared in triplicate. The original and duplicate are sent to the equipment division headquarters and the triplicate copy is retained in the division office.

In this way, parts and repairs are charged to the unit instead of to the job. The jobs thus pay for only the operating expenses such as gasoline, oils and greases, and the rental. In case of field repairs of major importance the mechanic's time is charged directly to the equipment and his time sent to the equipment division.

Detailed records are kept on each piece of equipment, which allows one to see at a glance the cost of operating and maintaining each unit. This information is absolutely necessary to enable the Department to know the condition of the equipment and the need for replacement; and by having this complete performance record on each unit of equipment the Department is placed in a favorable position to purchase additional equipment and replacements much more economically than heretofore. During the past it has been impossible to do this because the costs have been buried in the general cost of the different jobs.

Summing up the responsibility of the equipment division we find it now has jurisdiction over the purchasing, storing, distributing, maintaining and accounting of all construction and maintenance equipment and supplies, and that under this arrangement the equipment division has been made an important part of the organization, and that during the short time since the inauguration of this system the new policies have proven both feasible and economical.

The equipment division is now operating four division repair shops besides the headquarters shop in Reno. These shops are located at Elko, East Ely, Las Vegas and Tonopah. Each shop is in charge of a competent mechanic who is held responsible to the division engineer and the superintendent of equipment.

The Elko shop takes care of all equipment in Division No. 3, which comprises the counties of Elko, Humboldt, the eastern half of Pershing, and the northern halves of Lander and Eureka. At the present time this shop is the poorest equipped plant in the department. This condition is due to the fact that so far the State has not been able to secure the proper location or facilities for a state-owned plant and has been renting temporary shop room.

The East Ely shop, which supervises the repairs in Division No. 4 embracing the counties of White Pine, Lincoln, and the southern half of Eureka, is the best equipped division shop in the Department. This

shop is located in a large well ventilated building which also serves as the headquarters for the administrative offices of Division No. 4. Included in this shop's repair equipment is a drill press, lathe, compressor and power hammer, and a complete blacksmith layout. With this equipment, which is in excellent shape, the shop can handle repairs of all classes with speed and efficiency.

The Tonopah shop cares for all equipment repairs for the northern portion of Division 1, which comprises Esmeralda County and all the territory in Nye County north of Beatty. Up to 1928 the cost of repair work in this section was excessive because there was no adequate repair shop in the district. During 1928 the Department secured a state-owned plant which is being properly equipped to handle major repair work of all kinds.

The Las Vegas shop cares for the equipment in Division 1, which includes Clark County and the territory in Nye County south of Beatty. This shop is state-owned and was constructed and equipped during 1927 and 1928. It is modern throughout, and completely equipped to care for any emergency which may arise to the equipment under its supervision.

The headquarters shop in Reno supervises the general repair of the equipment in Division 2, which is made up of Washoe, Storey, Douglas, Ormsby, Lyon, Mineral, Churchill, the western part of Pershing and the southern part of Lander Counties. This shop does all of the general overhauling and rebuilding of all equipment belonging to the State Highway Department, and is one of the best equipped plants in the State. During the past year this plant has rebuilt five old war-issue F. W. D. trucks, in four of which a Debooster, or compound transmission, was installed which gave the trucks more power and consequently a longer life of usefulness; a Moreland 5-ton truck, and five G. M. C. trucks.

One of the greatest problems facing the equipment division, at the present time, is the purchasing of parts for repairs. The State Highway Department is operating 130 trucks of various sizes ranging from ¾ ton to 7 ton; 125 of these trucks were received from the Federal Government as surplus war material issued under Acts of Congress to the States for road building purposes. These trucks were built during the war period of 1917–1918, which makes them obsolete now, causing some difficulty in obtaining parts.

Besides rebuilding, maintaining and repairing all types of road equipment this shop manufactures for the Department's use special road drags of the Wisconsin type, with a scarifier attachment, at an average cost of $364.

During the biennium the equipment division purchased, with the approval of the State Highway Directors, the following new equipment:

2 Buick automobiles.
1 Ford automobile.
7 Chevrolet automobiles.
2 Chrysler automobiles.
2 Dodge automobiles.
1 Studebaker automobile.
1 Graham automobile.
2 8-foot graders.

1 Small grader.
5 Motor graders.
4 Disc harrows.
5 Spring-tooth harrows.
8 Road maintainers.
1 Concrete mixer, ¼ Cu. Yd. (second hand).
1 Tractor—30 Best.
3 Tractors—60 Best.
1 Baker snow plow.

A complete list of equipment owned and operated by the State Highway Department is as follows:

Automobiles

6 Buicks. Purchased by Department.
1 Cadillac. Received from Government.
9 Chevrolets. Purchased by Department.
2 Chryslers. Purchased by Department.
6 Dodges. Purchased by Department.
16 Fords. Purchased by Department.
2 Jewetts. Purchased by Department.
2 Nashes. Purchased by Department.
1 Oakland. Purchased by Department.
1 Oldsmobile. Purchased by Department.
1 Studebaker. Purchased by Department.
9 White Recon. and Staffs. Received from Government.

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Trucks

2 Chevrolets. Purchased by Department.
2 Fords. Purchased by Department.
23 F.W.D's. Received from Government.
1 Garford. Received from Government, in poor condition.
30 G.M.C's. Received from Government, 9 in poor condition but worth rebuilding.
1 Graham. Purchased by Department.
11 Heavy Aviations. Received from Government.
2 Kelly-Springfields. Received from Government. Unserviceable and obsolete.
4 Light Aviations. Received from Government.
9 Libertys. Received from Government.
7 Morelands. Received from Government.
14 Nash Quads. Received from Government.
1 Packard. Received from Government. Unserviceable and obsolete.
13 Pierce-Arrows. Received from Government.
10 Whites. Nine from Government; one purchased by Department.

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Tractors

3 Holts, 5-ton. Received from Government.
8 Holts, 10-ton. Received from Government.
1 Fordson. Purchased by Department.
5 Cadillacs, 2½-ton. Received from Government.
1 Caterpillar, 30. Purchased by Department.
3 Caterpillars, 60. Purchased by Department.

21

Trailers

12 4-wheel.
5 4-wheel, w-cookhouse, mtd.
4 2-wheel.

21

Miscellaneous Equipment

2 Boilers. (For heating asphalt.)
1 Bunker and screen.
2 Buckets, ¾-yard.
1 Bucket, ½-yard.
1 Bin, loading.
3 Conveyors.
1 Compressor, 8x8.
2 Crushers.
1 Crane, portable.
2 Distributors, oil. 1 Etnyre; 1 Kinney.
4 Drags, heavy.
6 Engines, gas.
24 Graders.
5 Graders, motorized.
5 Harrows, disc.
5 Harrows, tooth.
1 Loader, Mogul.
53 Maintainers.
1 Machine, paint.
2 Mixers, concrete.
1 Mower.
11 Pumps, water.
3 Plows, snow, push.
3 Plows, snow, Rotary.
4 Power plants.
1 Paver.
2 Road rollers.
1 Set generators.
2 Screen shakers.
1 Winch.

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THE AUDITING DEPARTMENT

Just as the individual, or business concern, has some principle by which future action is guided, so the auditing division of the State Highway Department has an incentive to promote its progress. This guiding principle is given as a short preface to the accounting manual and reads:

> Always bear in mind that credit is the medium which facilitates the business of the world and as such must be carefully guarded. It is in many cases our most tangible form of good will; therefore, in your business relations with the public, please make every effort to expedite and properly handle all accounts involving credit, this great medium of business. Never abuse this privilege by neglecting to promptly submit your accounts.

The auditing department does make a determined effort to live up to the advice given in the foregoing; and as a direct result of this effort it is found that very few misunderstandings have arisen between the Department and the vendor.

The work of the accounting department covers:

1. General accounting.
2. Federal accounting.
3. Progress payments.
4. County statements.
5. Claims, requisitions and purchase orders.

6. Engineers' weekly reports.
7. Payrolls.
8. Expense accounts.
9. Checks.
10. Motor vehicle license record.
11. Leave record.
12. Railroad ticket orders.
13. Plans record.
14. Personnel record.

1. A detailed distribution of accounts has been outlined to care for all operations of the Highway Department. Every claim bears a distribution which is posted by the bookkeeper. Each month a report is made showing all expenditures for the month; and each year a yearly report is made, giving the yearly expenditures.

The detailed distribution of accounts follows:

	Code	*Account*
1. ADMINISTRATIVE DIVISION—		
Executive Department	EX	Salary, State Highway Engineer.
		Directors' Travel Expense.
		Industrial Insurance.
Auditing Department	AD	Salaries.
		Office Expense.
		Travel Expense.
		Auto Expense.
		Industrial Insurance.
General Offices	GOS	Salaries, General Engineering.
Salaries		Salaries, Office Clerical.
		Industrial Insurance.
General Offices	GOG	Stock Accounts.
General		Telephone and Telegraph.
		Light.
		Water.
		Postage.
		Freight and Express.
		Office Expense.
Field Operations	FO	Railway Transportation.
		Auto Expense.
		Travel Expense.
Police Department	PS	Auto Tax.
Salaries		
Travel Expense	PTE	Auto Tax.
Auto Expense	PAE	Auto Tax.
Office Expense	POE	Office Expense.
		Industrial Insurance.
Special	SPEC	Road Mileage Survey.
		State Road Map.
		Traffic Surveys.
		Legislation.
		Traffic Audits.
		Advertising.
Miscellaneous	MISC	Bond Premiums.
		Biennial Report.
		Gen. Ind. Ins. (Property).
		Photography.
		General Expense.
		Insurance.
		Association Dues.

	Code	*Account*
Building Expense	BE	Building Repairs.
		Building Supplies.
		Miscellaneous.
Drafting Department	DD	Salaries.
		Travel Expense.
		Auto Expense.
		Supplies.
		Industrial Insurance.
Blue Print Department	BP	Salaries.
		Supplies.
		Industrial Insurance.
Testing Department	TD	Salaries.
		Supplies.
		Auto Expense.
		Travel Expense.
		Industrial Insurance.
		Research.
		Water Survey.
		Code 40—Gravel Wear Tests.
Survey Department	SD	Salaries.
		Field Supplies.
		Travel Expense.
		Auto Expense.
		Industrial Insurance.
Maintenance	MAINT	Salaries.
		Industrial Insurance.
		Office Expense.
		Miscellaneous.
		Travel Expense.
		Auto Expense.
		Equipment Repair.
		Equipment Rental.
		Signs.
Division No. 1—		
Salaries	A1S	General Engineering.
		Office Clerical.
		Industrial Insurance.
Office Expense	A1OE	Supplies.
		Telephone and Telegraph.
		Postage.
		Freight and Express.
		Office Rental.
Travel Expense	A1TE	Travel Expense.
		Auto Expense.

The same accounts appear for Divisions Nos. 2, 3, 4 and 5. The Division number in the "Code" after the letter "A" designates the Division against which the charge is made.

II. Equipment Division—		
General Equip. Pur.	GEP	Equipment Division.
		Maintenance.
		General Office.
		Auditing.
		Survey.
		Drafting.
		Testing.
		Right of Way.
		Building.
		Division No. 1.
		Division No. 2.
		Division No. 3.
		Division No. 4.
		Division No. 5.

	Code	*Account*
War Material	MISC	Freight. Handling.
Reno Plant, Constr.	RPC	Machine Shop Equipment. Sheds. Cabin. Yard Gate. Tool Room Bins. Pipe Rack. Office Cabinet. Bench. Shelves. Wash Rack.
Reno Plant, Overhead	RPO	Supervision. Salaries. Telephone and Telegraph. Industrial Insurance. Leave Accounts. Ground Rental. Office Supplies. Fire Insurance.
Reno Plant, Stock Acc.	RP–STK	Gas and Distillate. Oil and Greases Stock Parts. Stock Supplies. Stock Tires. General Supplies. Stockroom Operation.
Reno Plant, Gen. Yd.	RP–Yd	General Storage. General Yard. General Repairs.
Reno Plant, Mch. Shop	RP–MS	Shop Tools. Fuel, Light, Water. General Supplies. Equipment. General.
Reno Plant, Maint.	RP–Mt	General Yard. Machine Shop. Office.
Reno Plant, Eq. Fund	RP–EF	Equipment Repairs. Additional Equipment. Tire Fund. Equipment Rental. Overhead. Depreciation.

III. Surveys, Plans and Estimates, Right of Way—

County, Route, Section	S–R	Surveys and Reconnaissance.
	P–E	Plans and Estimates.
	R–W	Right of Way.
	B–D	Bridge Design.
	M–S	Material Surveys.

IV. General Maintenance—

County, Route, Section	G. A. No. S. A. No. C. M. A. No.	Cost of maintaining each county-route-section.

V. Accounts Receivable — A–R — Accounts collectible by Highway Department.

VI. Construction—

Construction Authority	C.–A.	Work done by State forces.

	Code	*Account*
10% Engineering	70 and 79 with contract No.	Engineering on which Federal aid is received.
State Furnished Materials	S. F. M.	Gravel. Cement. Sand, etc.
Progress Payments	Estimate No.	Contract No.
Refund of Payments		Federal. County. City. Others.

2. On each construction job or contract, on which Federal aid money is allowed, a ten per cent engineering fund is handled and accounted for separately and distinctly from the construction activities. This ten per cent fund is created on the basis of the total amount of work involved in the construction of a project; and only the engineering and contingencies applicable for Federal participation are chargeable to the fund, such as the salaries and expenses of the engineering forces, and extra and additional work required but not included in the original contract. All payrolls and accounts submitted which are chargeable either partially, or entirely, to the ten per cent fund on any contract must show the county, route and section designations as well as the number of the contract.

It is very important to know the charges against this fund so that they may not be confused with charges against other funds; for instance, salaries and expenses of survey parties engaged in setting construction stakes on any road contract are chargeable to this fund; but salaries and expenses of parties making location surveys are not chargeable to this fund. Hence, the bookkeeper must know exactly the kind of work on which a survey party is engaged.

Once every thirty days, as work progresses, a federal voucher, listing quantities and prices as per project agreement, is submitted to the Bureau of Public Roads for approval and payment. At the completion of a job a final voucher is submitted to the Bureau of Public Roads showing the final quantities and actual engineering expense as well as any overruns.

3. Progress payments to the contractor are made monthly in accordance with the progress payment clause in the standard form of contract. The information for the proper preparation of this progress estimate of work done is taken from the cost data reports of the job, which are kept by each resident engineer. When the original estimate for progress payment is received at headquarters, the bookkeeper checks it; then five additional copies are typed, and the estimate is considered a claim and is placed in line for payment through the regular claim procedure.

A 15 per cent retent is held by the State as a surety for the fulfillment of the contract. This retent is paid to the contractor at the expiration of the thirty-day period allowed for the filing of creditors' claims, and "such retained percentage shall be paid without regard to creditors' claims filed" (Section 15, State Highway Law, amended

1925). This 15 per cent retent is 15 per cent of the total estimate exclusive of the total amount of extra work orders and any materials furnished by the contractor to the State under special arrangement.

4. On the 10th of January of each year the State Highway Engineer, in accordance with section 10 of the State Highway Law, presents to the Board of County Commissioners of each county an outline of the work proposed on the State Highway System within the county, and by the same Act the Commissioners shall enter an order making available for State highway purposes the moneys in the County-State Highway Fund, and, if necessary, levy an annual tax for highway improvements in accordance with section 11. Said funds are to be expended under the direction of the State Highway Engineer upon the State highway within the county. After the contract is awarded, the auditing department bills the county for its share of the cost of construction.

5. A conscientious treatment is given every claim or bill. The history of an invoice may be interesting, and will show that fairness is anticipated both for the vendor and for the Department. Mr. Smith, a resident engineer, is placed in charge of a contract. He establishes headquarters within or near a town. He must have certain supplies. To obtain these supplies he sends to Department headquarters a blank called a "requisition" on which he requests permission to make purchases. This requisition, giving quantities and prices, is approved by the Highway Engineer, or his assistant, and is then sent to the auditing department, where a purchase order is issued. The purchase order authorizes the engineer to buy supplies as approved. The white copy of the order is sent to the vendor, the yellow copy to the engineer who requested the order, and the blue copy is kept at headquarters where a card record of it is filed.

When Mr. Smith buys supplies he must sign tags which are attached to the bill when it is submitted for payment. Mr. Smith checks the bill, attaches to it a form which shows the distribution of charges, and mails it to headquarters where it is dated and given to the auditing department. A clerk checks it against the purchase order as to quantities, prices, extensions, dates, etc. Then a State claim, listing name and address of firm and description of invoice, is made. The State claim is checked by another clerk who also sees that the bill has not previously been approved for payment. Fifteen or twenty claims are then numbered and placed in a list which must be approved by the Highway Engineer. After his approval, the list is segregated—the white copy of the State claim to which is attached the original of the invoice is sent to the State Auditor for his check. After the State Auditor approves the list of claims, it is given to the State Board of Examiners for checking and approval. If approved by the Board, the list goes to the State Controller who mails to the vendor a warrant in payment of the claim. The yellow copy of the State claim is mailed to vendor to show him what is being approved for payment. If an error is found in a bill, a note of correction (or a corrected copy of the bill) is attached to the yellow claim. The duplicate copy of the invoice and a form showing the distribution of charges are filed for record in the auditing department.

Due to the fact that the Board of Examiners meets only on the 5th and 20th of each month to pass on bills, payment may seem delayed, particularly if a bill has to be sent into the field for explanation or correction.

A card record of every bill is kept by the auditing department. This record gives dates and description of purchase, employee's name and amount of invoice.

A detailed history of freight bills as made by the auditing department shows, at any time, the status of every bill (when it is received, to whom sent for approval, when returned, by whom checked, list and claim in which it is filed).

6. The weekly reports, listing amount of work done on each contract, are checked as to contract items, quantities and prices; then are filed according to contracts.

7. Payrolls for men on construction and surveys are made by the chief of party and sent to headquarters. Time cards for men employed on maintenance are sent to headquarters. Payrolls are made from the time cards.

When the Department employs a man an employment record is made; white copy is kept by auditing department; blue copy and pink are kept by the engineer in charge. When a man is discharged, or his rate is changed, the blue employment record is sent to the auditing department where it is filed with the white record.

When the payroll is received it is checked as to employment record, rate, days and extensions. Then a pay check is written and its number is recorded on the payroll. A letter of transmittal for the check must be written so that the Department may have an accurate record of each check. After the check has been written the payroll is handled in the same manner as invoices.

8. Certain employees are entitled to expenses when traveling on Department business. All expenses are listed on expense accounts which are checked as to dates, items and rates ($6 within Nevada and $10 outside). Permission to travel outside the State must be granted by the Board of Examiners; therefore, a copy of the letter authorizing the trip must be filed with the expense account. These accounts are paid by check.

9. A record is kept of all checks and their reimbursement. And a reconcilement with the bank and with the State Controller's office is made each month.

10. A card record is kept of every motor vehicle showing engine number, serial number, date of purchase, name of vendor, purchase price and special parts. A license record by years is kept on the motive equipment card.

11. When an employee has worked for the Department 10 months he is entitled to an annual leave of 15 days, and to sick leave for 10 days with pay. The leave record is posted on the personnel card of each employee.

12. Several of the railroads have given the Department permission to use ticket orders; for example, Mr. Smith must go by rail from Reno to Ely. He requests a ticket order. This order is made out for Mr. Smith who must sign it in person before the railroad will give him

transportation. A stub record of the ticket order is kept by the auditing department. At the end of the month the railroad submits its bill accompanied by the original ticket order. Orders, stub record and rates are checked.

13. A fee of $15 is charged for a set of plans and specifications for contemplated construction which is let by contract. To the successful bidder the $15 deposit fee is returned. To the unsuccessful bidder $10 is refunded when he returns the plans and specifications in good condition within 30 days after opening of bids. In case the plans and specifications are not returned, the deposit of $15 is forfeited. A complete record of each transaction is kept by the auditing department.

14. On the 5th and 20th of each month a personnel list is given to each member of the Board of Directors of the Highway Department. This record lists all recommendations for appointments and changes in titles and rates as well as resignations and discharges. After the list has been approved the record is posted on a personnel card which gives a complete employment history. Then letters are written to those concerned advising them of the action of the Board.

In 1927 an audit of the books and records, as kept by the highway accounting department, was made by Hood and Strong of San Francisco. In September, 1928, the annual check was made by the State Auditor. As a result of these two audits no serious criticism has been offered.

Financial Tables Nos. 22, 23 and 24 follow:

REVENUES AND EXPENDITURES

Graphic presentation of the relative amounts of revenue derived from different sources and the relative amounts expended for different purposes.

TWO YEAR PERIOD

Dec. 1, 1926 to Nov. 30, 1928.

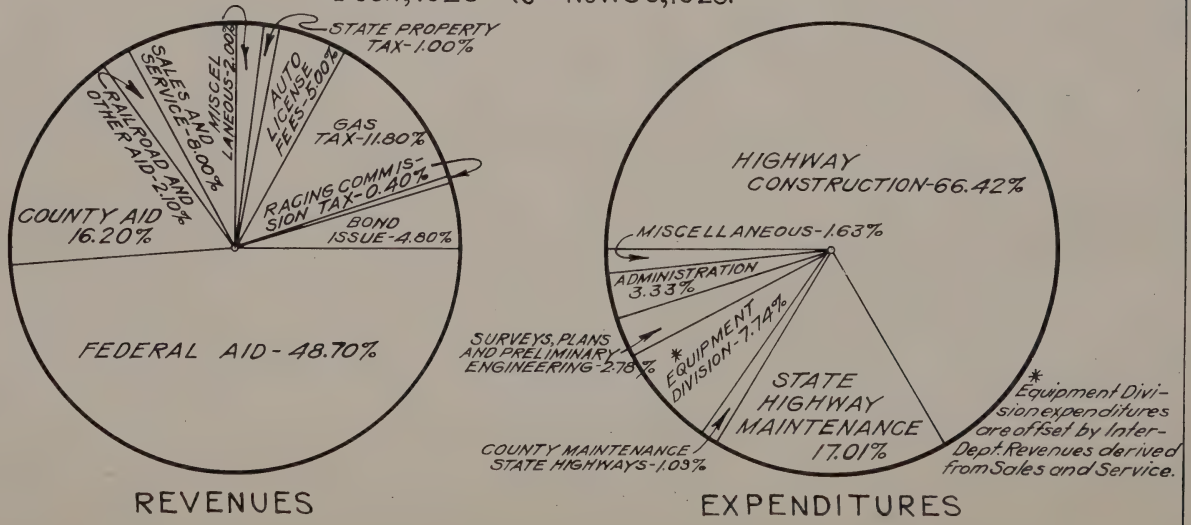

TABLE No. 22—STATEMENT OF RECEIPTS

Class of income	1917 to 1926	1927 and 1928	Total	Per-centage
Legislative appropriation	$40,000.00		$40,000.00	.20
Taxes, net amount received	1,224,352.48	$43,422.65	1,267,775.13	6.43
Automobile license fees	503,149.82	207,546.60	710,696.42	3.61
Gasoline tax fees	446,538.76	493,232.62	939,771.38	4.77
Racing Commission fees	110,691.24	18,660.94	129,352.18	.66
Miscellaneous refunds	9,029.25	15,029.05	24,058.30	.12
Sales and service (Inter-Department)	700,794.19	335,073.14	1,035,867.33	5.25
Right of way refunds	6,076.78		6,076.78	.03
State Highway bonds	900,000.00	200,000.00	1,100,000.00	5.58
Federal construction refunds	7,933,135.27	2,036,479.25	9,969,614.52	50.57
County construction refunds	2,883,875.93	586,916.65	3,470,792.58	17.61
County maintenance refunds on State work		59,000.00	59,000.00	.30
County maintenance refunds	39,386.92	34,057.82	73,444.74	.37
Lincoln Highway Association	71,426.60		71,426.60	.36
Utah-Nevada-California Association	23,831.47		23,831.47	.12
San Francisco—Bay City		25,000.00	25,000.00	.13
City construction refunds	136,491.07	9,002.65	145,493.72	.74
Railroad crossing construction refunds	98,198.55	55,028.10	153,226.65	.78
Special maintenance deposits	2,000.00		2,000.00	.01
Accounts receivable	374,533.30	67,764.60	442,297.90	2.24
Lahontan Plant depreciation	24,397.90		24,397.90	.12
Totals	$15,527,909.53	$4,186,214.07	$19,714,123.60	100.00

TABLE No. 23—STATEMENT OF DISBURSEMENTS

Classification	1917 to 1926	1927 and 1928	Total	Per-centage
Highway construction	$11,870,936.36	$2,743,383.59	$14,614,322.95	74.88
County maintenance	37,220.46	45,016.54	82,237.00	.42
Surveys, plans and preliminary engineering	578,772.88	114,763.26	693,536.14	3.55
Plant inventories	100,323.55		100,323.55	.51
Equipment inventory accounts	331,886.13	34,107.47	365,993.60	1.88
Reno plant	459,179.22	285,665.38	744,844.60	3.82
Lahontan plant	19,671.35	*1,534.03	18,137.32	.09
Hafed plant	1,560.86		1,560.86	.01
Vista plant	26,844.79	*9,527.30	17,317.49	.09
Accounts receivable	359,411.19	67,179.14	426,590.33	2.19
Sec. 31, refunds and special transfers	40,107.17		40,107.17	.21
General administration	627,963.34	137,571.47	765,534.81	3.92
Maintenance	943,774.33	702,661.36	1,645,435.69	8.43
Total	$15,396,654.63	$4,119,286.88	$19,515,941.51	100.00
To balance, invested capital			198,182.09	
Grand total			$19,714,123.60	

*Credit

TABLE No. 24—ESTIMATED BOND REDEMPTION
As Prepared November 30, 1928

Year	Redemption of principal each year	Interest payments	Estimated license receipts	Estimated balance available
1920	$90,000.00	$654.15	$103,758.58	
1921	100,000.00	29,126.99	102,410.32	
1922	60,000.00	17,920.48	120,944.38	$29,405.01
1923		42,660.00	153,888.10	111,228.10
1924		25,640.00	181,969.85	156,329.85
1925	50,000.00	32,569.40	209,231.02	126,661.62
1926	100,000.00	31,750.00	209,919.71	78,169.21
1927	100,000.00	30,097.22	229,839.32	99,742.10
1928	100,000.00	27,835.42	250,000.00	122,164.58
1929	150,000.00	22,250.00	250,000.00	77,750.00
1930	150,000.00	13,500.00	250,000.00	86,500.00
1931	100,000.00	6,750.00	250,000.00	143,250.00
1932	100,000.00	2,125.00	250,000.00	147,875.00

Total Bonds Issued $1,100,000
Total Authorized by Legislature 1,300,000

TYPOGRAPHICAL
UNION
LABEL
WASHOE